MAY 28 1927

WATER-WORKS NUMBER

Engineering News-Record

Devoted to Civil Engineering and Contracting. McGraw-Hill Publishing Company, Inc.

May 26, 1927

Pipe Gallery of Oakland, California, Filter Plant

THERE are included in this issue approximately thirty pages of articles of primary interest to the water-works engineer, builder and operator. In them are described the construction of a new dam in Oregon, a covered reservoir in Wisconsin and an intake in Illinois, and the development of a new supply in Texas. Shorter articles, covering ten pages, describe new methods and practices developed by a score of water-works men from Iowa, Ohio, Maryland, Minnesota, Michigan, Pennsylvania, Nebraska, Connecticut, Georgia, Kansas and Massachusetts

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

McGraw-Hill Publishing Co., Inc.
JAMES H. McGRAW, *President*
E. J. MEHREN, *Vice-President*

FRANK C. WIGHT
Editor

Volume 98 | NEW YORK, MAY 26, 1927 | Number 21

The Valiant

"WHAT I ha' seen since ocean-steam began leaves me no doot for the machine: but what about the man?" Thus Kipling's McAndrew full thirty years ago. The doubts persist, but every so often comes a Lindbergh to allay them. Dauntless, unafraid, calculating, ideally combining skill, judgment and courage, the gentlemen adventurers blaze new paths in man's achievement. Back in the shops dreamers and workers put together the machine. It remains for the valiant, who "taste of death but once," to prove the invincibility of the human spirit.

Water-Works Financing

THERE are indications that the spirit of consolidation which has so marked the electric power field is finding another outlet in the privately owned municipal water-works. In the past year there have been a number of such consolidations or, more especially, the taking over of minor isolated plants by an existing holding company. There are not as many privately owned water-works in the country as those operated and owned by the cities themselves, but such as there are evidently offer a promising financial opportunity when conducted under the well known economies of group control. Where such economies are valid there can be no objection to such consolidation, but the history of the other public utilities makes it necessary that the public utility commissions scrutinize most carefully the financial setup of any extension of control. The non-voting stock, the reproduction-cost-new contention, the highly profitable inside control of the end profits, everything that goes to offset the real economies of unit direction, can be applied to water-works just as well as to power plants, and the consumer needs to be protected as well against one as the other.

Water Enough

A PROPOSAL to add a sewage-works section to the American Water-Works Association will be considered at the Chicago convention, June 6 to 11. In the light of the information and opinion now before us, adoption of the proposal would be unwise. Sewage problems are already being actively considered by sections of the American Society of Civil Engineers and the American Public Health Associations, and are given attention by the American Society for Municipal Improvements. In one state—New Jersey—a sewage-works association has been in existence for years, and is steadily growing in quality of work and in members. Its membership outside the state is increasing. It has just voted to publish a report of its proceedings quarterly and open them to pertinent papers read before other societies. In other states, sewage-works conferences are being held. For the present and immediate future, the agencies named seem capable of handling sewage-works topics. An increase in state societies and conferences dealing with sewage problems should be welcomed, with co-operation always in view. A large majority of the members of the American Water-Works Association have little or nothing to do with sewage treatment. For them, water is enough.

Court or Commission?

IN REJECTING the application of the Kansas City Southern Railway Co. for permission to form a new railroad system through control of the Missouri-Kansas-Texas R.R. and the St. Louis Southwestern Ry., the Interstate Commerce Commission avoided giving a definite decision on important points by the method so frequently employed by the Supreme Court, that of saying that it is not called upon to decide such and such points because the application is being rejected on other grounds. Possibly this procedure is correct enough for the Supreme Court in deciding delicate points of law, but it is wrong for a commission set up to administer a law. As was pointed out in the dissenting opinions, the Transportation Act was passed to facilitate railroad consolidations and the commission was given wide latitude of action to bring them about. For the commission to reject applications on one point without giving the applicant the benefit of its judgment on all the important points in its proposal is not only unfair to the applicant but tends to defeat the object of the Transportation Act. The commission is not a court but an administrative body. When considering such applications it should give its views on all important points, approving or disapproving as necessary rather than rejecting the whole proposal simply because it does not approve of any one feature. By such a process, the applicants will learn immediately wherein their proposal does not meet with the commission's views and as a result they will be saved the time and expense involved in adjusting their plans to meet the commission's views point by point.

Accord at Geneva

DOUBTLESS there is more than a fair amount of cynicism as to the real value of the International Economic Conference which has just adjourned at Geneva. Progress toward world reform is at best glacier slow and contemporary observation avails little as a gage. Having that in mind it is worth recording that some accomplishment may be accredited to the Geneva meeting. Accord was established in many important points and a common understanding of common views was reached in many of the details that govern the industrial conduct of the world. In these days of

international misunderstandings that was a step forward. Mr. Mehren's dispatches in this issue emphasize the high spots of the conclusions reached. To Americans the thing of interest is the glorification of what the Germans call "rationalization," that is the whole industrial system of mass production, waste elimination, simplification and high wages that has come to represent in Europe the basic industrial philosophy that has put America ahead in the last decade. That acceptance of our method of thought and action premises a more intense competition in world markets than we have known for the last prosperous years and makes more necessary than ever that we consider thoughtfully the accompanying resolutions for the removal of trade barriers and for the development of international cartels. The best economic and industrial minds of Europe and America came together to discuss these questions. These men cannot force their countries to act, but that they have learned each other's thoughts and have, to a degree, agreed on future action, promises something for better co-ordination among those who do direct the separate destinies of the nations.

New Tunnel Mucking Machine

ROCK tunnel mucking has been one of the latest construction operations to be successfully mechanized. The attempts for thirty years have been many, but the difficulties were great and increased as the bore of the excavation decreased. Mechanical mucking first succeeded, though perhaps it was not first undertaken, when short-boom steam shovels were put into the larger diameter (two-track) railway tunnels. At best the steam shovel of a quarter of a century ago was a bulky device, its exhaust was a strain on ventilation, its fuel supply required haulage service generally already too scant for handling pay material, and its mobility was none too facile. Search turned toward special excavators and loaders and invention produced a number, but few of them endured beyond their initial operation, and some of them were pulled out of the tunnel long before the bore had been well advanced. It is not the place, here, to schedule progress, but in the last decade and especially within the last five years, the rock-mucking machine for tunneling has come to be a comparatively efficient and reliable device as many examples of tunnel construction described in *Engineering News-Record* have demonstrated. In general, these muckers have been in essence power shovels. It is of interest therefore, to note in the recent Chicago water-works tunnel operation described in this issue, the successful use of a cable dragline mucking outfit. The device is working in a comparatively small bore, and, more significantly, is taking out both heading and bench excavation with only very simple changes in adjustment from heading work to bench work. The new device deserves notice by tunnel builders.

The Question at San Francisco

WHETHER San Francisco will stand alone among large American cities in depending on a private company for its water supply will be determined, for the time being, on June 14. We say for the time being, because it is hardly conceivable that a swing from private to municipal ownership will be much longer delayed. Against long delay there is, first, the force of example. Of the eighty larger cities of the country, only a dozen, and of thirty largest, San Francisco and Indianapolis are the only ones supplied by private water companies, standing Nos. 11 and 21 in list. For a half century, there has been agitation for municipal ownership of water-works at San Francisco, and although proposals to that end were defeated at the polls in 1910, 1913 and 1921, the principle of municipal ownership, as regards this and other utilities, is embodied in the city charter. The principle was further endorsed by the popular vote to build the Hetch Hetchy dam and aqueduct at a cost of many millions. There were reasons for the defeat of the purchase proposal in past years which cannot be gone into here. Presumably, some of them no longer exist or have been weakened. Whether chiefly as a rallying point for the opponents of municipal ownership, or from honest conviction, the main reasons openly urged against the purchase are that if the property were bought it would be entrusted to the board of public works, described as a political body. It is urged that purchase should be postponed until a water board, or else a utility commission to take over all municipally-owned utilities, can be created. What assurance can be given that such a body would not also be political, we do not know. Such boards, largely divorced from the city government, are the exception in at least the larger American cities. They are at variance with unified city government. Voters at San Francisco will do well not to be led from the main issue—public or private ownership—by the talk about waiting for a water board or utility commission. If they have cause to fear their present city government, why not provide themselves with a better one, to the advantage of not only the public water supply but also of the many other elements in city administration?

Shun Montreal Typhoid Dangers

EXCEPT for the Montreal typhoid epidemic itself, which persisted for ten weeks and then flamed out afresh after totaling some 2,600 cases, nothing associated with it has been so remarkable and deplorable as the attitude of the city council. This is particularly true of the council's executive committee, which ordered the discontinuance of daily case reports just after the new outburst and then dilly dallied for at least two days over the order of the director of the Provincial Bureau of Health to shut off the supplies of two *unlicensed* dealers said to be responsible for at least a majority of the cases.

Aside from ignorance, which we will be charitable enough to put aside, there are but two explanations of this attitude and inaction: An alliance of political and commercial interests to protect milk producers and distributors and a silly notion that full publicity as to the cause and extent of the epidemic would keep business and pleasure seekers away from Montreal. The first we will not pursue beyond saying that rumor points that way. As to the second, attempting to hide the facts of an epidemic always does more harm than good. It begets rumors that are uglier than any facts could be. It delays needed action and public support for action which may have to be drastic.

Some time ago the U. S. Department of Agriculture put an embargo on milk produced within 200 miles of Montreal. Considerably later, the U. S. Public Health Service published a warning against typhoid carriers from Montreal. That was when the outbreak was thought to be

over. Since the recrudescence of the epidemic, a gathering of health officials representing various American states, convened in Washington and, quite independently, a local medical society in Montreal have adopted resolutions expressing lack of confidence in the way the Montreal epidemic has been handled, as stated elsewhere in this issue—where also may be found evidences of further local concern, shown by a meeting called in the interests of the tourist agencies, hotels and railways in Montreal.

With one set of commercial interests thus set against another behind the milk dealers, their financial and political backers may be defeated, provided the general public, led as it now is by the physicians, will only assert itself. Meanwhile, those fortunate enough to live outside of Montreal and its environs will do well to shun the typhoid dangers lurking therein and to be on their guard against those coming from that city until they are proved not to be typhoid carriers.

Why An Engineering Board?

REPORTS from Washington indicate that the administration does not look with favor at this time on any plan for studies of flood control on the Mississippi by other than the Corps of Engineers and the Mississippi River Commission. And from most credible sources the reasons for this view are given as follows: "The feeling is that the Corps and the Commission are more competent to report on the steps which should be taken to safeguard the valley than would a special committee of engineers appointed for the purpose. It is held that no engineer in private practice has had extended experience in connection with the control of the river. Before a group of outside engineers could make intelligent recommendations a time-consuming process of education would have to be allowed. The needs of the present situation call for a prompt report which will be made by the Commission not later than Oct. 1. Attention is called to the fact that four members of the Mississippi River Commission are civilians. The other three are army engineers, but all members have had extended experience in the handling of the practical problems of flood control and have given all phases of the subject intensive and continuous study. The present members of the Commission have before them the results of the intensive studies which have been carried on by the Commission since its creation in 1879."

If this really represents the view of the President, it seems to us that he misunderstands the situation. He is being bombarded from all parts of the country for action on the Mississippi. Politicians, anxious for partisan advantage, are yelping for an extra session of Congress. Mr. Coolidge is both shrewd enough and sound enough to resist this demand for he knows that Congress in the next six months can contribute nothing more to the serious consideration of the problem than can the hurrah-boys "flood control conference" that Mayor Thompson has called for next week in Chicago. Other earnest gentlemen among them Gifford Pinchot and Franklin Roosevelt are joining certain newspapers in a cry for a "flood control commission" to carry a few engineers, but apparently to be dominated by publicists, economists, business men, etc., whose duty it would be to formulate a broad flood control policy both for the Mississippi and for the entire country. Such a commission would make policies, not solve an engineering problem, and there is no emergency demand for a flood control policy. That can wait until Congress meets.

But the engineering basis for such a policy needs to be laid immediately. The six months before Congress meets is none too long for the study that must be made, for the assembly of all of the old facts and their comparison with the new ones revealed in the current flood. This the President recognizes, for he has directed the Chief of Engineers to make such a study. What this journal has urged, and will continue to urge, is that this be supplemented by a report of a board of consulting engineers, comprising enough of the Mississippi River Commission to make available the data that body has in hand, but dominated by engineers who have not been connected with the Commission.

We advocate this in no opposition to the Commission. As has been stated several times in these columns we believe that body to contain the best available knowledge and experience of the Mississippi problem. But the Commission suffers from the fact that it has not been able to prevent the floods, and opposition to it on that score takes no account of the fact that it has had neither proper appropriations nor full local co-operation to carry out its plans. The fact remains that because floods continue to cause damage all of those who have schemes different from those that the Commission proposes will gain an audience because their schemes, not having been tried, at least have the advantage of never having failed.

There is, therefore, a decided necessity of having to present to Congress something more than the report of the Commission. We take no stock in the argument that outside consulting engineers cannot be obtained with sufficient experience to make their opinion worth while. What is needed here is not experience with this particular problem, but engineering judgment, and that certainly is not the exclusive possession of the gentlemen of the Mississippi River Commission. What is needed is a visé on that Commission's report, or if that cannot be obtained a reasoned criticism of its recommendations. Engineers can be found to do this, to add confidence to what the river men report, or to indicate weak spots in their armor. This is common practice in all engineering. It is no criticism of an engineer's ability to have a consulting engineer look over his work. That is all that is asked here: to have applied to the highly expert and intensive views of the Mississippi River Commission, the broader perspective of the best engineering judgment of the country.

The Commission may change its plan of control of the Mississippi. We have it on the best of authority that its members object to the statement that they are committed to any plan. But it is highly doubtful that they will recommend anything more than an extension of the levee system as a major cure for the floods. That being the case the whole tribe of anti-levee enthusiasts, the reservoir and forestation advocates, the parallel channel or new river disciples, will make a strong case of prejudice against the Commission.

For its own protection the Commission should welcome intelligent engineering consultation. To ease the way of any plan of control through Congress the President should recognize the desirability of some confirmatory supervision of the Commission's study.

New Dam Will Double Water Supply of Portland, Ore.

Gravity Concrete Structure 200 Ft. Above Bedrock Will Have Central Spillway Slide, Automatic Outlet Gates Above Dam and Needle Valves to Below Dam to Control Outflow

By D. C. Henny
Consulting Engineer, Portland, Ore.

THE RISING curve of summer water consumption at Portland, Ore., never crossed the falling curve of summer flow of Bull Run River, the source of supply, until the year 1924. As the combined storage of the city distributing reservoirs is only 175 m.g.d., or only three times the daily summer consumption day after day, it became evident that no time should be lost in supplementing the only storage in the drainage area, that afforded by Bull Run Lake.

VIEW OF BULL RUN LAKE ON HEADWATERS OF WATER SUPPLY OF PORTLAND, ORE.
Mount Hood and Cascade Divide in background, looking east

Accordingly studies of stream flow were made and a concrete dam to form an additional reservoir commanding 74 sq.mi. of drainage area was designed. This reservoir, which will store some 10,000 m.g. of water, together with the existing storage, will sustain a seasonal demand draft 2.13 times larger than the present, which will suffice for a population of 800,000 at the present midsummer consumption rate of 150 gal. per capita per day. The dam will be 200 ft. high above bedrock and 180 ft. above low water in the river; of the gravity type, curved upstream with a radius of 600 ft., and with a crest length of 935 ft. Features of the dam are: (1) A spillway midway in its length, with a curve at the toe of the dam to change the direction of flow to horizontal, a heavy apron, at the end of which there will be a low weir to form a pool. It is expected that water will flow over this spillway most of the time. (2) Outlet tower against front of dam with automatically controlled sluice gates at various levels and automatic butterfly gates. (3) Butterfly gates at upper end of outlet pipes and needle valves at lower end, discharging into open air. The needle valves will control the reservoir discharge. (4) Penstocks for future power works. Construction of the dam and reservoir is under way. The contract for the dam requires (1) that it be completed to store water at 100 ft. above the weir level by May 1, 1928, so as to store 8,000 acre-ft. (2,600 m.g.) for use during the ensuing summer; and (2) full completion by Dec. 31, 1928.

In addition to the special features of the dam, arrangements are being made for the installation of telemeters, resistance thermometers, piping for measurement of uplift pressures and gage points for measuring opening of contraction joints, all under the supervision of a special committee appointed by Prof. Charles D. Marx, chairman of the Committee on Arch Dam Investigation, Engineering Foundation, with the writer as chairman of the special committee.

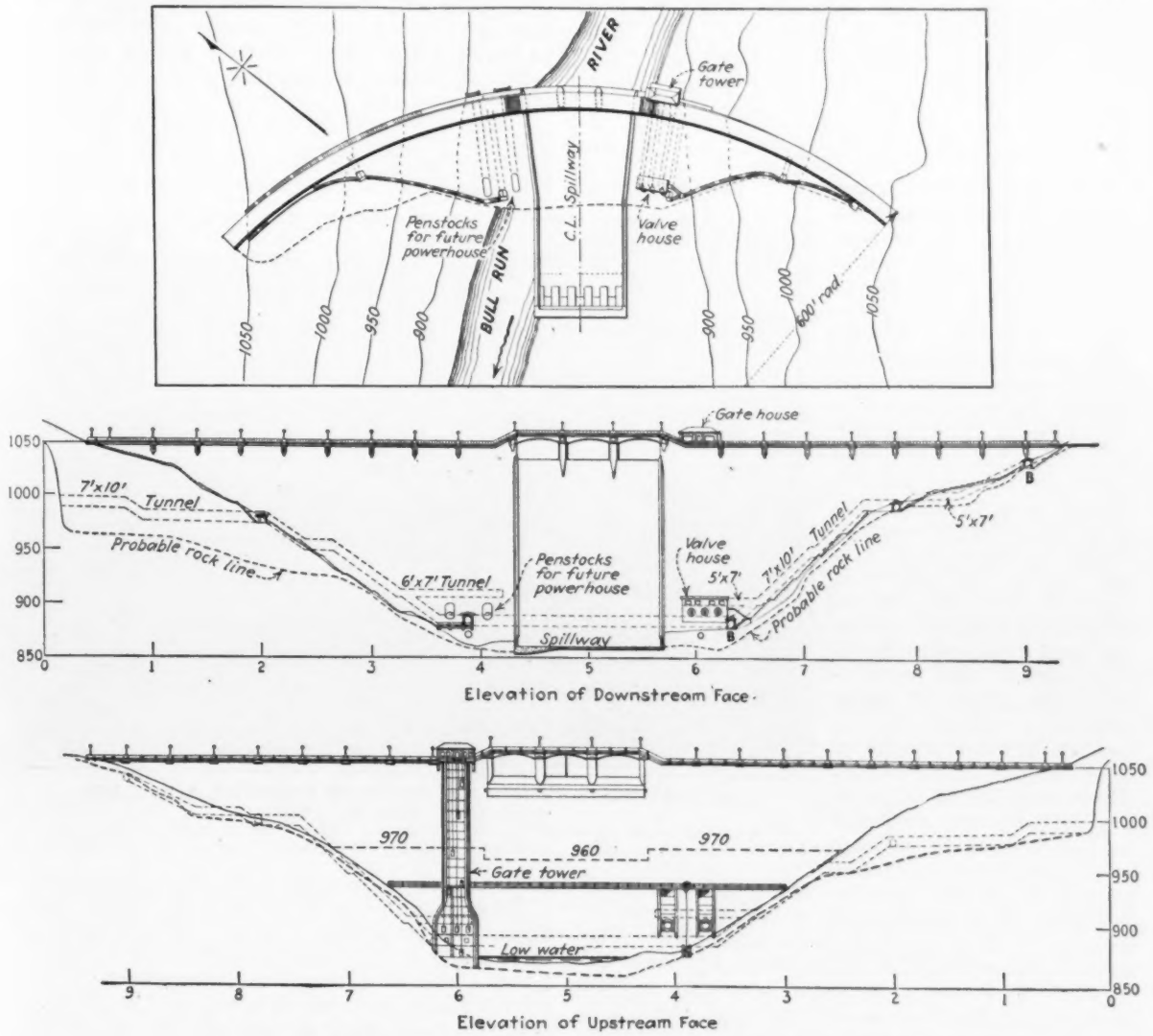
Before describing the dam in detail some notes on the source of supply and the variations in its yield will be given.

Water Source—The drainage area of Bull Run River above the Portland water-works intakes is 103 sq.mi., all heavily wooded, and all in the U. S. Forest Reserve. From the point of intake three steel supply conduits lead 25 miles to the upper distributing reservoir, in Portland. These were complete in 1895, 1911 and 1925, and have capacities of 25, 50 and 74 m.g.d., or a total of 149 m.g.d.

The only storage in the drainage area is afforded by Bull Run Lake, near the headwaters of Bull Run and about 19 miles above the intakes. For the 21

years, 1895 to 1925 inclusive, the average flow of Bull Run (at the intakes) was 840 sec.-ft. The maximum flow occurs in January or February and has ranged during the period of record from 5,000 to over 17,000 sec.-ft. The flow then recedes gradually to about 250 sec.-ft. in early June, after which rain ceases and the flow drops during ordinary years of low rainfall to 100 sec.-ft. in July and 90 in August.

Thus, with the lake 10 ft. above the lowest outlet and holding 4,300 acre-ft. on Aug. 1, it can supply during the following 100 days, when no fall rains may occur, 21.5 sec.-ft., which is close to an uncontrolled outflow. If this is supplemented during August and September, it must be at the expense of later outflow, which may be needed if fall rains are seriously delayed. Release of water from Bull Run Lake, if it does not stand



PLAN AND ELEVATION OF BULL RUN DAM, PORTLAND WATER-WORKS

Bull Run Lake has a surface area of about 450 acres and a drainage area of 4 sq.mi. In its natural state it showed surface outflow only during the spring months, after which its outflow continued under ground at the rate of about 22 sec-ft. A low dam was constructed at the outlet, zones of heavy seepage were blanketed and the lake now fluctuates with a range of 20 ft. with a slightly reduced uncontrolled outflow. The increased capacity and a low outlet structure at the dam permit the uncontrolled outflow to be supplemented to an extent dependent on the previous spring inflow, which does not always fill the lake, and on the amount of uncontrolled outflow prior to the time when reinforcement of river flow is required. higher than 10 ft. on Aug. 1, is therefore resorted to only with hesitation.

The water demands of the Portland territory have been steadily climbing with the increase of population served, which in 1895 was 75,000 and is now estimated at 395,000. About 92 per cent of the taps are metered. The average daily per capita consumption is 108 gal., increasing in summer to 150 gal. and during brief hot spells, usually lasting not longer than three days, to 225 gal. With a daily consumption of 160 gal. during extended periods in July and August the demand averages 60 m.g.d. or 93 sec.-ft., falling off in September to 75 sec.-ft.

Late in August occurs usually the closest approach

of city demands to river supply, occasioned by a continuance of high lawn sprinkling consumption with a slowly falling river flow. After that time the demands drop off faster than does river flow, which begins to pick up even in the absence of early rains through decreased evaporation. It is therefore the flow between Aug. 10 and 31 which ordinarily controls the question of sufficiency. During this brief period it has usually been possible to keep the river flow up through release from Bull Run Lake. Low August flows (sec.-ft.) since 1895 have been:

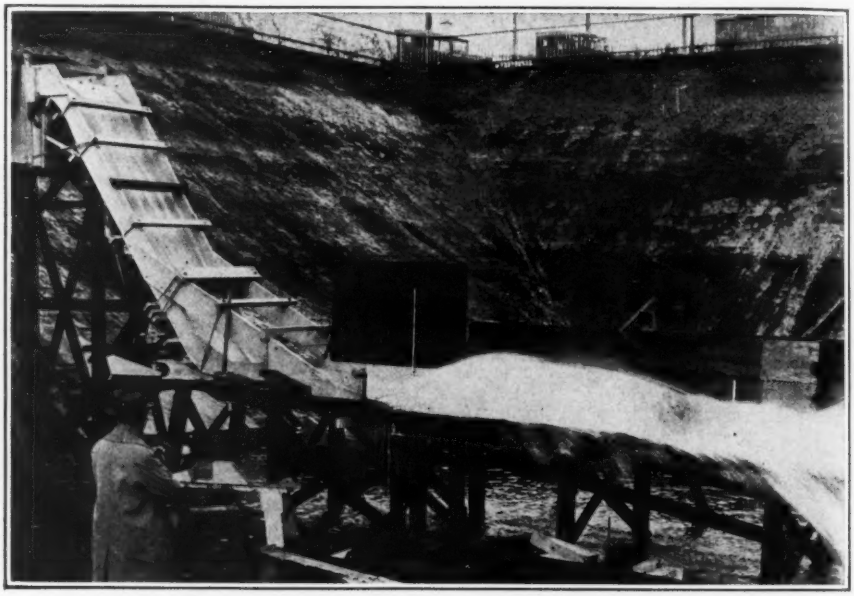
	Lowest	Average		Lowest	Average
1901	90	122	1915	92	133
1907	98	127	1920	91	119
1910	82	89	1924	71	87
1912	92	249	1926	63	125
1914	72	87			

Prior to 1924 various degrees of lawn sprinkling restrictions had become necessary. These were due to insufficient capacity of supply or of city mains. In 1924 low stream flow became the controlling factor and in that year restrictions took effect on July 23 and were made quite drastic from Aug. 2 to 27.

Dam Location and Construction—The Bull Run River gradients are steep and the stream runs between steep mountain slopes in a narrow valley. Ideal storage sites do not exist and all storage is relatively expensive. In continuation of earlier studies by the local water department, six reservoir sites were located (in 1913) in which practicable storage can be created in the aggregate of 95,000 acre-ft. or 31,000 m.g. About one-third of this storage, or 10,000 m.g., is found in the so-called Bear Creek site on the main stream, five miles above the city pipe intake, and this site, commanding 74 sq.mi. of drainage area, is the one selected for first construction. A complete geological study of the dam site was made by Ira A. Williams of Portland. Extensive underground explorations, completed in 1926, disclosed excellent bedrock, consisting of black tight basaltic lava, generally free from seams but higher up on the slopes open textured at contact planes.

The borings across the narrow river valley developed artesian flow at depths of from 25 to 60 ft. below the surface of the rock which was found to be practically level at about 10 ft. below the surface. The artesian pressure, when first measured, was 75 lb. per sq.in. The source of this water is not known. If it comes from the river itself it must travel at least 2½ miles underground without loss of pressure. The opening up of one well causes a material drop in pressure in all other wells and the aggregate flow is small, not exceeding 1 sec.-ft. The water may come from the side hills but this seems improbable because contact planes between various flows of lava have a nearly level position across the stream and water on its downward course would have to traverse several of these planes with probability of pressure reduction by slow drainage towards the river gorge. Whatever may be the source of this artesian flow it seems safe to conclude that the heavy basalt layer upon which the dam across the valley will rest is tight over an extensive area.

The new dam was designed on the assumption of 148 lb. per cu.ft. as the weight of dry concrete. Seams in the rock will be grouted to a depth of 50 ft. below base or deeper if found desirable and the dam will be provided with drain holes penetrating rock. The design is based on the assumption that at any elevation there may be uplift of full waterhead reducing on a straight-line basis to zero at the plane of drainage and that this pressure acts upon 100 per cent of the area. With such uplift it was required that there be no tension at any point in the dam, and in the calculation dam slices were assumed along vertical planes. In this manner a downstream slope was found to be required of 0.70 with slightly flatter slopes below the level of downstream submergence. The resultant maximum pressures are figured at 188 lb. per sq.in., reservoir empty at heel, and 305 lb. per sq.in., reservoir full at toe parallel to downstream slope, with sliding factor 0.708.



FLUME USED IN STUDIES FOR DESIGN OF SPILLWAY, APRON AND POOL WEIR, BULL RUN DAM
The view shows an actual flow of 5.91 sec.-ft., representing a 21,000-sec.-ft. flood flow over the proposed dam.

A feature of the specifications is a provision for thorough control of aggregates and water-cement ratio, including the use of inundators and, if necessary, dehydrators. The aggregates will be screened to ¾-, 3-, and 9-in. sizes, in approximate proportions of 1, 1.2 and 1. Cement is expected to run ¾ bbl. per cu.yd. A field laboratory will be installed at the dam, supplemental to the city testing plant.

The dam will be built with contraction joints 40 ft. apart. The curvature of the dam is intended to increase the safety, especially in case actual uplift should at any point exceed the uplift assumed, or should estimated flood flow be exceeded. Seepage through construction joints will be prevented by a

system of keys and by built-in copper water stops.

Concrete deposition will be directed so as to produce a minimum temperature rise at the time of first concrete set after closure at contraction joints to keep opening of joints, due to ultimate cooling, at a minimum.

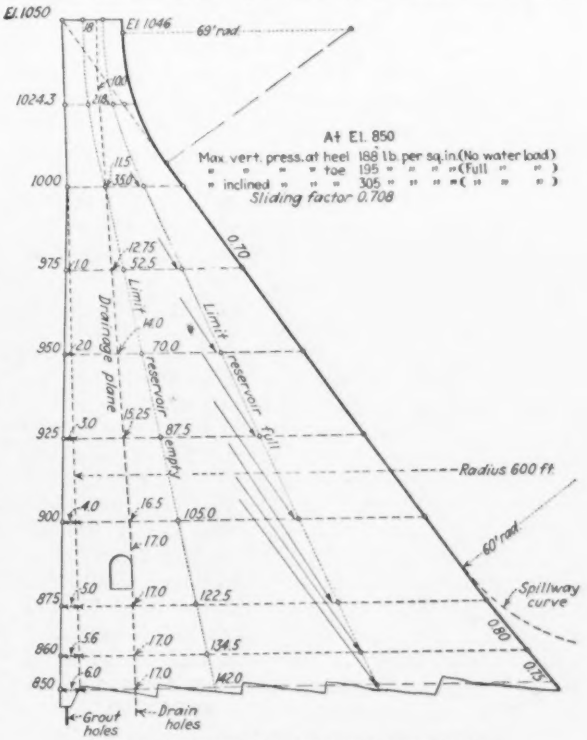
Excess flood water will be spilled over the central portion of the dam through three spillway bays 40 ft. wide, with a fixed crest 14 ft. below the top of the dam. These bays will be built so as to permit the ultimate installation of drum gates raising the water 10 ft. above the fixed crest or to within 4 ft. of the top of the dam. Until gates are installed the controlled storage will be reduced from 31,000 to 27,300 acre-ft. Elaborate studies made by F. F. Henshaw indicate that the flood flow to be expected from the 74 sq.mi. of drainage area above the dam will not exceed 21,000 sec.-ft. The spillway is designed to pass such a flood with water even with the top of the dam. Any further rise of water will rapidly increase spillway discharge capacity but will not cause overflow of the dam as the water will be held by a parapet wall.

The spillway crest is formed on the downstream side so as to correspond with the maximum discharge parabola until intersected by the downstream slope. At the toe, a curve with a 60-ft. radius will change the direction of flow to horizontal, the bedrock being protected for a distance of 150 ft. by a heavy concrete apron. At the downstream end of the apron the water will be deflected upward by a weir 5 ft. high, with 2½ to 1 and 5 to 1 upstream slopes for alternating widths of 10 ft. This design is the result of experiments with a model on a scale of 20 to 1. The effect is the discharge of the water in two types of parabolas with different reach and spread, resulting in a distribution of impact on the rock river bed below, over an area of 40 to 180 ft. downstream from the spillway end. The area from 0 to 40 ft. from the spillway end will be practically free from erosive attack. This design of spillway was adopted in part because destruction of energy by a standing wave was not possible since the river is on so steep a gradient that river flood flow always proceeds at less than critical depth.

Flood probability curves show that spillway flow will take place the greater part of the time and that it will not exceed 3,500 sec.-ft. for more than 2 per cent of the time. With such flow there will be no impact on the rock downstream for a distance of 20 ft., or 170 ft. from the toe of the dam. With the usual spill flow of 1,000 sec.-ft. or less a pond 10 ft. deep will be maintained over the spillway with an energy absorbing wave at its upper end. It is estimated that this pond will not be cleared until the flow reaches about 2,500 sec.-ft. which flow will occur for only 4 per cent of the time.

Controlled reservoir outflow will be through a gate tower, placed against the front of the dam, provided with racks and with 7 sluice gates, 3x6, 6x8 and 4x6 ft. in size, located at various elevations. The water in this gate tower will never be more than 8 ft. below that in the reservoir. Four automatic gates near the bottom of the gate tower will open whenever the pressure difference exceeds 8 ft., an arrangement which permits the high gate tower to be of comparatively light construction.

From this gate tower water will pass through three 4-ft. pipes with 4-ft. butterfly gates at the upper end and with 3-ft. needle valves at the lower end, placed in a gate house on the downstream slope of the dam and discharging into the open air. Actual quantity control will be had by the needle valves, the sluice gates being intended merely to permit water to be drawn off at the most desirable depth. The maximum pressure on the needle valves will be 155 ft. They will be equipped so that distant electrical control can be installed at any time. Their outlet capacity is figured at 500 sec.-ft., which may be required when all reservoirs higher up in the basin shall have been



STRAIN SECTION OF BULL RUN DAM

built. This capacity is intended to be attained by two gates at low-water elevation, the third being held in reserve for emergencies. Vertically below these gates a 3x6-ft. sluice gate is to be installed with its sill at the present river level, to be operated by hand from a stand in front of the dam which will ordinarily be submerged, which can not be reached until pressure on the gate is reduced to 60 ft.

Future Power—For the development of such power as the utility may need in the future there will be installed in the dam two 90-in. penstocks. Immediate construction will be confined to a rack structure upstream, butterfly gates near the face of the dam, and pipes passing through the dam closed by drumheads. A 3x6-ft. sluice gate will also be installed vertically below the penstock inlets.

The dam will have a simple ornamental finish at the top, with raised concrete arch bridges over the spillway opening. The higher level of these bridges will be gained by stairways which are purposely intended to block future vehicular travel over the dam. This blocking is principally for sanitary reasons, the entire drainage area being excluded from public use and travel, and access to it being under strict control of the Forest Service and public health officers.

A heavily macadamized road 6 miles long is necessitated by the dam construction. It will be used for bringing in cement, gates and supplies, the aggregate required for the dam being obtained from gravel beds in the river below the dam, which will be transported by a construction railroad about four miles long.

The fact that the city pipe-line intakes are five miles below the dam makes it imperative that the water be protected from contamination while the dam is being built. The main construction camp will be provided with a thorough sewer system, with septic tank, chlorination plant and electrically driven pump. An electrically driven pump will raise the treated sewage 1,100 ft. over a divide and discharge it into a creek entering Sandy River below the mouth of Bull Run. Outlying small camps of contractors for reservoir clearing will be equipped with incinerators and the entire sanitation will be under the co-operative control of the State Board of Health.

At the city pipe intakes an emergency chlorinator will be on hand and periodical bacterial tests of the water will be made to test the complete efficiency of the sanitation measures.

The road giving access to the dam site is completed. The contract for clearing was let to Heller & Co. in November, 1926, for $171,000, covering 434 acres. The contract for dam construction, exclusive of cement, steel and gates, was let to Bent Bros. in February, 1927, for $1,450,000. The volume of concrete is estimated at 230,000 cu.yd. The contract for 36-in. needle valves and 48-in. butterfly gates was let to the Pelton Water Wheel Co. for $17,500, and that for the 66- and 90-in. butterfly gates to the Joshua Hendy Co. for $24,300, and for the sluice gates to the Coffin Valve Co. for $10,400. Contract for the cement was placed with the Santa Cruz Portland Cement Co. at the net price of $2.49 per barrel delivered at Bull Run station 30 miles from Portland. Estimated cost of the work, including investigations, drill boring, force account work, sanitation, and engineering, is $3,000,000.

The work is under the control of the Portland Bureau of Water-Works, John M. Mann, city commissioner, with Ben S. Morrow, chief engineer of the Portland water department, and Ben E. Torpen in direct charge of the dam, the writer acting as consulting engineer. A. J. Wiley has been consulted in connection with selection of type of dam and spillway.

Committee Studies of Boiler Feed Water

One of the problems being considered by the Boiler Feed Water Studies Committee of the American Water Works Association, according to statement sent to *Engineering New-Record* by V. Bernard Siems, vice-chairman of the committee, is the effect of municipal water treatment upon water that is to be used by the industries, especially in steam boilers. In addition, two specific phases of municipal water treatment are being studied by a sub-committee: (1) recarbonization of public water supplies for prevention of retarded chemical reactions from municipal softening plants; (2) the economic effect of the addition of lime to inhibit corrosion. The present indications are that the use of soluble salts, especially sodium compounds, may be equally as valuable as lime for preventing corrosion and that they have the added advantages of not producing scale-forming solids and of not requiring that as much soap be used in laundries, etc.

Concrete Mixer Speeds Construction of Slag-Clay Road

By Samuel Knopf

Principal Assistant Engineer, Delaware Highway Department, Dover, Del.

A NOVEL method of spreading slag was used in 1926 in building a slag-clay road, 3.40 miles long from Harrington to Masten's Corner, in Kent County, Delaware. This is a secondary type of road used on local feeders to the state highway system. About 23 miles of this type were built during 1926 averaging 12 to 14 ft. wide and, after compaction, 6 in. thick.

Most of these roads were laid down by the regular methods of building macadam roads, with the exception that the slag was bound with roadside material and slag screenings without the application of water. All were spread by a mechanical spreader, advanced along the subgrade by chains attached to the trucks delivering the slag and averaging 600 to 900 lin.ft. per day, the footage depending on the number of trucks, hoisting arrangements, and delays in attaching the spreader to the truck.

This particular contract used a different method of introducing the slag to the spreader. After the subgrade was prepared a 21-cu.ft. mixer which had just completed a concrete roadway contract was used as the means of delivering the slag into the spreader. The bucket was run out to the end of the boom and at the discharge end of the mixer a wooden chute with a flare discharged the slag into the spreader uniformly.

The spreader was attached securely to the frame of the mixer and moved along as the mixer advanced, spreading the slag 7½ in. deep in one layer. Slag was delivered to the mixer by Ford trucks with built up sides, which hauled approximately 2 tons each. About 40 trucks of this type were used and the mixer was kept continually in operation. The slag after being dumped into the skip was revolved through the drum down the discharge chute into the spreader as fast as a batch was ready to be hoisted. Six men kept the subgrade in shape and five men were at the spreader to fill depressions and spread a thin layer of roadside material over the slag. This layer was allowed to dry and afterwards was agitated into the slag by means of one man operating a spike toothed harrow pulled by a horse. After this operation the slag was rolled by a ten-ton roller, reshaped, and slag screenings applied and rolling continued until the screenings had filled the voids. The shoulders and ditches were afterwards finished by a road machine with very little hand labor.

The maximum day's run by this method was 2,600 ft. or 725 tons of slag in 9½ hours, the average for the contract about 2,000 ft. per day and the actual laying of the slag required only 9 working days; the day's run depending on the ability of the unloading and loading devices at the yard, the number of trucks and the footage of subgrade already prepared.

Preparation of subgrade was expedited at a saving in cost. As the proposed grade and alignment followed the present road, the subgrade was shaped by 2-hp. crawler tractors with blade attachments, each operated by one man and a helper who staked out the grade and alignment. The subgrade was crowned and enough material was windrowed each side to bind the slag when laid.

Field, Barker & Underwood, of Philadelphia, Pa., were the contractors and built a good roadway in record time.

Restoring a Small Water Supply Ruined by Landslide

Slide Into Stream Continuing to Cause Turbidity, Diversion Dam and Pipe Line Are Built by Village of Ellenville, N. Y.

By Henry W. Taylor
Consulting Engineer, New York City

A LANDSLIDE occurred in the spring of 1924 which ruined the water supply of the village of Ellenville, N. Y., by seepage of highly turbid water, from the bowl formed by the slide, into the stream which carried the water supply to a point of diversion into the village distributing reservoir. The turbidity having continued for two years, a diversion dam and a pipe line, from above the slide to the distributing reservoir, were built in 1926. The landslide, its effect and the remedial measures are described in this article.

The landslide occurred on North Gulley Creek, about 4,000 ft. above the distributing reservoir. This stream is Ellenville's principal source of water supply, but is supplemented by water from Maratanza Lake, which is diverted into the headquarters of the creek through a tunnel pipe line, discharging above the site of the landslide.

The landslide filled the width of the stream gorge with liquid clay, uprooted trees, rock, fine sand and débris, and the torrential flows of the stream carried much of the material the full length of the stream and into the main stream in the valley below, a distance of over two miles. After the spring flows had ceased, the remaining deposit from 5 to 15 ft. deep, continued to move down the gorge of the stream by its own fluid action, like molten lava. The material displaced is crudely estimated at about 350,000 cu.yd. The initial effect of the slide on the character of the water can easily be pictured. It was thought by many of the local authorities that the situation would correct itself shortly, by the caving of the fresh bank of the mountain to an angle of repose, and the healing of the scar with vegetation. Not until the situation had been endured for two years, were corrective measures applied.

The continued effect of the slide on the water supply was caused principally by a trick the slide performed at its lower margin. The firmer material, trees and rock, formed themselves at the bottom angle of the slide area in a natural dam. This action gave rise to a bowl of slushy material behind the dam, highly fluid, which sought out the unfilled voids in the natural dam structure and drained itself into the stream below. New material from the slide thus fell into an earthen bowl of fluid material, containing enough moisture to convert the new material into a soggy mass of clay and fine sand. Rainfall reaching the bowl increased the fluid character of the mass, caused head for further leakage through the natural dam, and continued the pollution of the stream below.

After the spring flows of the stream had subsided, the creek wore out a new channel, cutting out the clay and sand until a bed of gravel was reached. The bowl behind the slide was superficially drying up and no considerable overflow took place. The first rain, however, raised the creek sufficiently to bring about a change of course, produced new drainage from the slide bowl, and forced the creek to clear a new channel before the initial clarity of the water could be approximated. After two years the slide was still caving, the water still ruined with suspended matter and color, and the bowl of the slide was still operative on small provocation. The water, at all times, had a milky appearance, and with little warning was changed to look like rich chocolate. Its potability, untreated, was always a matter of question from a physical point of view, and at its worst one would very reluctantly bathe in it.

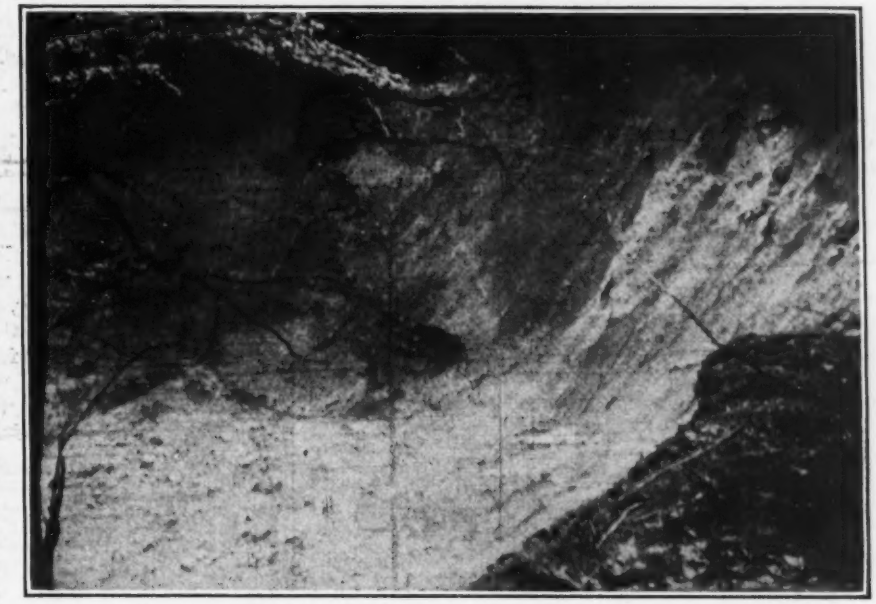


FIG. 1—LANDSLIDE THAT RUINED WATER SUPPLY OF ELLENVILLE, N. Y. Displaced material, estimated at 350,000 cu.yd., went into gorge through which stream flowed, as shown by Fig. 2.

The material causing the greater damage to the water supply consisted of a very fine clay which when relieved of its matrix, became practically colloidal and went into a mechanical solution in the water. A very small proportion of this material was sufficient to discolor the entire supply. It could not be completely removed by filter paper, except with a coagulant. Only the heavier and darker suspended matter would settle out.

The accompanying view, sketch plan and section give an idea of the slide, the bowl behind the bottom angle of the slide, and the condition of the stream gorge. On several different inspections of the slide in 1924, the writer noted the creeping action of the material in the stream gorge. When sun-dried, a top crust formed which made walking on the material possible, but even when slightly moist it was ex-

tremely dangerous to attempt crossing the stream gorge. The width of the slide, parallel to the axis of the stream, is at present about 300 ft. Its depth from the old bottom angle of the gorge is about 500 ft., and the top angle of the slide is about 150 ft. above the former level of the gorge. A large detached boulder, about 25 ft. long, protected a point of land sufficiently to divert the creek toward the base of the slide, so the bottom of this area was always lubricated with moisture. There was a roadway benched into the side hill in the slide area and the gutters of the roadway received drainage from the slope above and carried it past the area of the slide. It is the theory of many in the locality that this drainage water found porous material below in the area of the

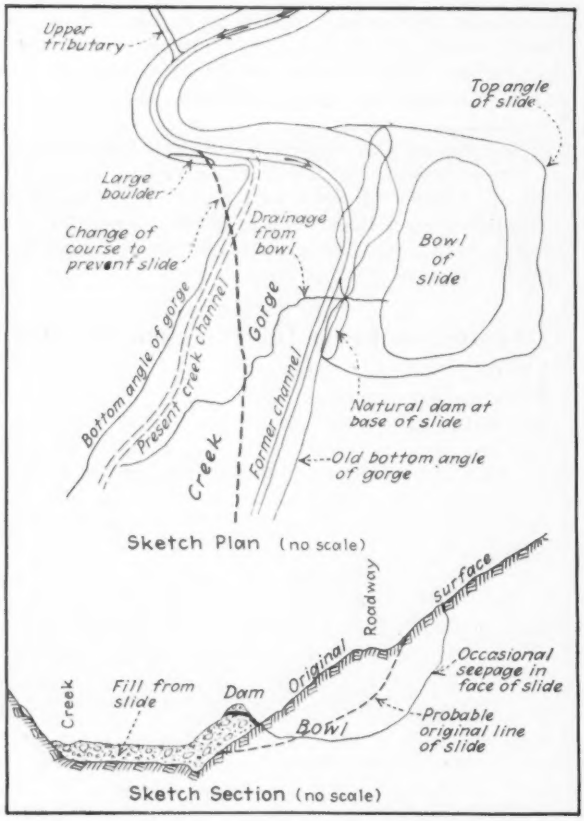


FIG. 2—SKETCH PLAN AND SECTION OF SLIDE
Gorge of stream carrying Ellenville water supply partly filled with clayey earth, sand, boulders, trees, etc. New channel formed, but dam at toe of slide formed bowl from which clay and other finely divided material seeped into stream, especially in wet weather.

slide, and provided a vertical lubrication to assist in the sliding action.

A previous slide of lesser dimension, which took place several years ago, is indicated by distinct markings, just outside the present slide area. A wood crib was built at the bottom angle of the gorge, in the attempt to prevent further slides here and to keep further material from reaching the stream. It is probable that the area of the old slide had not had an opportunity to develop sufficient vegetation to heal over the old scar and overcome a continued sensitiveness to further sliding action. The slide occurred in connection with heavy flows in the creek, which no doubt not only lubricated the toe of the slope but probably under-cut it, while at the same time lubricating water may have been supplied from a considerable area by means of the road ditches, which traversed the upper part of the sliding area.

In the sectional sketch the dotted line shows the probable cleavage of the original slide. The original cross-section changed itself to that shown by the full

FIG. 3—PIPE LINE DIVERSION AROUND LANDSLIDE
Before covering. Leads to distribution reservoir.

line, due to the log dam of trees and mud which developed the bowl indicated within the area of the slide. After three years, the mountain face exposed by the slide is practically vertical, with a slight hangover at the top where vegetation and tree roots hold the material together, until they are undercut by caving of material below. New material from the face of the slide now falls into the bowl where there is always enough water to make a rich and strong mud which percolates through the voids in the natural timber and mud dam on the outer margin of the bowl.

The writer is of the opinion that if after the first slide the course of the brook had been changed, as shown on the diagrammatic plan, the slide would not have taken place. It may also be that if the upper lubrication by water from the roadway had been diverted above the area of the slide, the slide might have been prevented.

So far as the water supply was concerned, there was nothing to do except to filter the water with use of a coagulant, or to intercept the good water before it had been tainted with the material from the slide. As the water was of unusually clear mountain spring quality, and as the shed is owned entirely by the village, filtration would be used only for its physical effects and it was the writer's opinion that even were a filter installed, it would be a difficult matter to secure uniformly clear water, comparable to the natural flow of the stream. It was therefore decided to divert water from the stream at a point above the landslide.

This was effected in 1926 by building two small diverting dams, one on North Gulley Creek about 500 ft. above the slide, and the other on a tributary to the main stream, about 800 ft. above its point of discharge into the main gorge, and laying universal cast-iron pipe from (1) the dam on the tributary to an open manhole at the lower dam, which receives water diverted by this dam and (2) from the manhole to the distributing reservoir. The line from the upper

diverting dam consists of 500 ft. of 10-in. and 1,300 ft. of 8-in. pipe, and from the lower dam, 2,400 ft. of 8-in.

The design of the intercepting dams called for some study, as anything but a shallow saucer-shaped pool would quickly fill up with the spring flows, which carry large boulders and much débris. The dams consisted chiefly of concrete aprons installed on top of rock fill laid on flat slopes. Drop aprons to clay, where it could be found, cut off underground flow.

The new pipe line was laid along the side of the mountain to keep it out of reach of the effects of torrential ffows in the gorge of the stream valley. The joints of the universal pipe were especially adaptable to this line, which was laid in snake-like form

FIG. 4—VIEW OF ELLENVILLE AERATING FOUNTAIN
Composed of six ¾-in. plain brass nozzles spaced about 30 in. c. to c. in wrought-iron header in corner reservoir. The corner post of the wire fence hides the lower part of one of the jets.

along the line chosen in the field for security and to eliminate any horizontal sections. In many cases, the pipe line was laid on a fill behind a dry wall to save difficult rock excavation and trenching (Fig. 3) and then covered to a depth of about 1 ft. to afford protection against the weather. The overflow manholes and valving of the line are so arranged that it is impossible to shut off the flow in the pipe though it is possible to divert it or any section of it so that it will not reach the distributing reservoir. The upper line is always full of running water; the lower line either full of running water or self-drained.

Due to the fact that the old intake, not far above the distributing reservoir on the lower reaches of North Gulley Creek, was unfortunately located and dimensioned, being subject to chokage from torrential flows with heavy débris, the new supply delivered to the reservoir, although from a lesser area, delivers more water than was previously available and the new pipe line has solved problems other than the slide and provided a water of ample quantity and in its natural state of clarity and purity.

At the distributing reservoir, a 6-nozzle aerator throws the water into the air about 80 ft. through 2½x¾-in. brass nozzles, visible from the valley at Ellenville for a distance of 3 to 6 miles. The aerator consists of a 6-in. genuine wrought-iron header spanning one corner of the existing reservoir. In the header there were installed three 6x2½-in. crosses, spaced about 30 in. c. to c., and from these crosses short lengths and elbows deliver water to the six nozzles. The twin nozzles at the ends are spaced about 30 in. and the twin nozzles in the center are spaced about 5 ft. so that a line drawn from nozzle to nozzle would form a hexagonal figure. Outside this corner of the existing reservoir a concrete apron was installed to return the aerated water to the reservoir proper.

The entire cost of the work described was approximately $25,000, divided as follows: Pipe and fittings purchased by village direct, $8,500; general contract for installation of work, $13,500; miscellaneous, including engineering, $3,000.

Protection Levee Built in Colorado Delta

IN PREPARATION for the coming season's floods in the lower Colorado River a new protection levee has been built in the delta region, south of the old Bee River channel. It extends from the Pescadero levee at mile 29½ west and southwest to the embankment of the Mexicali & Gulf R.R., and is roughly parallel to the Volcano Lake levee and 7½ to 8 mi. southeast of it (see map of delta in *Engineering News-Record* of March 17, p. 441). The new levee is known as the Rodriguez Levee. According to Paul M. Entenman, of Banning, Calif., the levee was built 13 ft. wide on top with side slopes of 1 on 2, and is 7½ ft. high on the average, bringing it 4 ft. above high water mark for a 200,000-sec.-ft. flow. The Mexican government contributed 20 per cent of the cost, the remainder being defrayed by the owners of the Mexican delta lands. The levee was built between March 28 and May 10, with equipment comprising eight draglines from ¾ to 1½-cu.yd. capacity and 1,000 head of mules. In this short period a total of 900,000 cu.yd. of earth was moved, something over 22,000 yd. per day. The draglines first dug a deep muck trench, and then refilled it with material from borrow pits on the land side. Next a core levee was constructed with teams and fresno scrapers. Finally, the full section was completed by the dragline. Construction was under the direction of W. I. Bassett, chief engineer of the Mexicali & Gulf R.R.

It is expected that this levee will not only protect the lands to the north of it against high flood levels, but will also do much service in lower floods, since a flow of less than 50,000 sec.-ft. will about reach its toe. Having no revetment and lacking a railroad on its top for emergency revetting, it is not as safe as the regular revetted levees of the delta, but it is expected to reduce flood danger even if breached, since much of the flood flow of the river will probably have passed down to the Gulf before the breach occurs.

Moving the 440-Ft. Truss Spans of Sixth St. Bridge, Pittsburgh

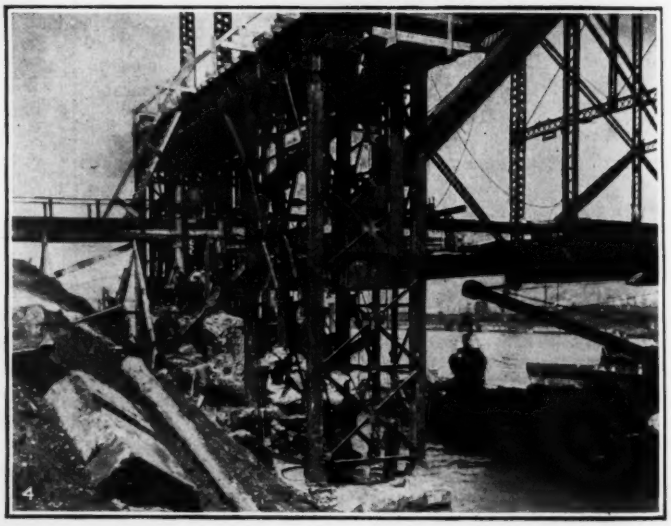
Old Allegheny River Crossing to Be Removed—Spans Floated Downstream to Replace Old Highway Bridge

By D. T. Jerman
Engineer, The Foundation Co., Pittsburgh

SIXTH ST. bridge across the Allegheny River at Pittsburgh was ordered removed by the War Department several years ago as an obstruction to navigation, its headroom and clearance width being insufficient to accommodate the increased traffic on the Allegheny River. The removal order included also two other downtown bridges, at Seventh and Ninth Sts. These latter were rebuilt during the past two years, the old structures being taken down and scrapped. Sixth St. bridge, the last of the three to be renewed, had a superstructure that was considered still suitable for lighter service, and the county therefore decided to remove it some miles downstream and re-erect it as a highway bridge across the back channel of the Ohio River between Neville Island and Coraopolis.

Accordingly, the Department of Public Works of Allegheny County, under Norman F. Brown, director, contracted with The Foundation Co. to remove the bridge from its present location and re-erect it at the Coraopolis site. It was decided to accomplish the removal by floating the spans integrally on scows.

The bridge consists of two spans, each 440 ft. long, 44 ft. wide, 80 ft. high, weighing 1,600 tons each (Fig. 1). The south span was taken in hand first; the north span will follow.



REMOVING SOUTH SPAN OF SIXTH ST. BRIDGE OVER ALLEGHENY RIVER, PITTSBURGH

Fig. 1—Sixth St. bridge before work began.
Fig. 2—Supports at river pier.
Fig. 3—Jacks, billets and pin at top of the links.
Fig. 4—Tower at the south bank.
Fig. 5—Span afloat on barges.

To lower the spans to the scows on which they are to be floated, the contractor designed a steel tower capable of carrying the ends of both spans at the center pier, and a similar tower for the south end of the south span, the latter to be subsequently moved to the north end of the north span. The towers were erected by cutting recesses in the stone masonry and transferring the load from the shoes to the tower (see Figs. 2 and 3). After the load had been transferred to the steel tower the masonry was removed and the bridge was ready for lowering.

Each shoe was supported on four tension plates or steel straps, 18x1 in., 47 ft. long, punched with 26 holes 7 in. in diameter and 15 in. from center to center; the spacing of holes was made to correspond with the runout of the jacks. The jacks bore against a billet, which in turn bore against one of the steel pins passing through the straps.

After the load was taken by the jacks, a lower pin was removed and the jacks were allowed to bleed until the next hole could be caught down below and pinned off. The jacks were then further released and the billet and upper pin moved up 15 in., to the next hole. The lowering operation was thus repeated, hole by hole, until the span rested on the barges.

Four 500-ton hydraulic jacks were used in the operation.

The span was lowered onto four steel barges, each of 1,000 tons capacity, fastened together in pairs and placed longitudinally with the span. Blocking was placed on the steel girders that fastened the barges together, at each panel point of the span, so that the span is resting at 42 points. In this nest of blocking there are set ordinary screw jacks of 40 tons capacity, to be used subsequently in relieving the tension in the top-chord pins.

After the span was loaded on barges, which took one day, it was moved endwise so that the shoes cleared the center pier tower, and then swung downstream, where steamboats took hold of it and towed it to the north shore of the Allegheny River above Manchester bridge.

Due to the fact that there is not sufficient clearance under either the Manchester bridge over the Allegheny or the Ohio Connecting R.R. bridge over the Ohio River, to pass the span, it will be necessary to take off a portion of the top chord so as to decrease its height and enable it to pass under the bridges. This method was decided upon as being safer than an attempt to submerge the barges, and probably a cheaper method in view of the fact that two bridges must be passed. The span is to be transported down the Ohio, passing under the two bridges mentioned, through the Emsworth lock, and up the back channel of the Ohio, and placed in position on new piers which are built for its reception, at the crossing from Neville Island to Coraopolis.

As soon as the present span is placed on its foundation at Coraopolis, barges and blocking will be brought back to Sixth St. to receive the north span, and the process described will be repeated.

The south span was successfully removed on May 4, and it is expected to transport it to its new location, river conditions permitting, by June 1.

The work was planned and carried out by the Pittsburgh office of The Foundation Co.

Mississippi Floods Not a Development of Recent Years

A GREAT flood which occurred in the Mississippi River in 1543 was described by Garcilaso de la Vega in a history of De Soto's Expedition on the North American Continent, entitled "La Florida del Inca." It is a record that goes a long way toward proving that deforestation has had little or nothing to do with the floods which occur in the Mississippi valley. The volume containing the description of the flood was found by Glenn W. Caulkins, superintendent of schools, Cashmere, Wash., while in Peru. A translation of it was published recently in the *Wenatchee Daily World.*

The account begins by describing how Fernando De Soto sailed from Havana, Cuba, in 1539, landed at what is now Tampa, Fla., and traversed Florida, Georgia, North and South Carolina, and Alabama. He crossed the Mississippi, which he called the Rio Grande, near Memphis and traveled through Arkansas and Louisiana, returning to the Mississippi, where the remnants of the expedition while preparing boats to go down the Mississippi to reach Mexico were attacked by Indians. At that juncture a flood occurred in the Mississippi which was described as follows:

Then God, our Lord, hindered the work with a mighty flood of the great river, which, at that time—about the eighth or tenth of March (of 1543)—began to come down with an enormous increase of water; which in the beginning overflowed the wide level ground between the river and the cliffs; then little by little it rose to the top of the cliffs. Soon it began to flow over the fields in an immense flood, and as the land was level without any hills there was nothing to stop the inundation.

On the 18th of March of 1543, which that year was Palm Sunday, when the Spaniards were marching in procession the river entered with ferocity through the gates of the town of Aminoya, and two days later they were unable to go through the streets except in canoes.

The flood was 40 days in reaching its greatest height, which was the 20th of April, and it was a beautiful thing to look upon the sea where there had been fields, for on each side of the river the water extended over twenty leagues of land and all of this area was navigated by canoes, and nothing was seen but the tops of the tallest trees.

On account of these inundations of the river the people build their houses on the high land, and where there is none, they raise mounds by hand, especially for the houses of the chiefs; the houses are constructed three or four stages above the ground, on thick posts that serve as uprights and between uprights they lay beams for the floors, and above these floors which are of wood, they make the roof, with galleries around the four sides of the house where they store their food and other supplies, and here they take refuge from the great floods. The floods do not occur every year, but when in the regions where the rivers have their source there have been heavy snows the preceding winter with rains in the following spring; and thus the flood of that year of 1543 was very great on account of the heavy snow which had fallen the preceding winter. These floods occur every 14 years, according to what an old Indian woman told us, which can be verified if the country is conquered as I hope it will be.

* * * *

Towards the end of April the flood began to subside, as slowly as it had increased, so that even by the 20th of April the Spaniards were unable to walk in the streets except by wading in the water.

* * * *

By the end of May the river had returned within its banks.

Building 6-M.G. Covered Reservoir at Madison, Wis.

Circular Concrete Reservoir with Counterfort Outer and Partition Walls—Roof Carried by Walls and by Columns—Concrete Placed by Crawler Crane and Bucket

By L. A. Smith
Superintendent of Water-Works, Madison, Wis.

BEFORE proceeding with the design of a 6-m.g. covered reinforced-concrete circular high-pressure reservoir for the water-works of Madison, Wis., a rather complete study of existing reservoirs in the United States and Canada was made, as well as of reservoir failures. Engineering periodicals and books in the engineering library of the University of Wisconsin were the sources of information. This study revealed the rather remarkable fact that about three out of every ten concrete reservoirs built prior to 1924 failed to give satisfactory service. It was apparent that a very conservative design was imperative and that extreme care was necessary in planning the details. After careful study a site at suitable elevation for a reservoir to float on the distribution system was found on soil which was a mixture of sand and clay.

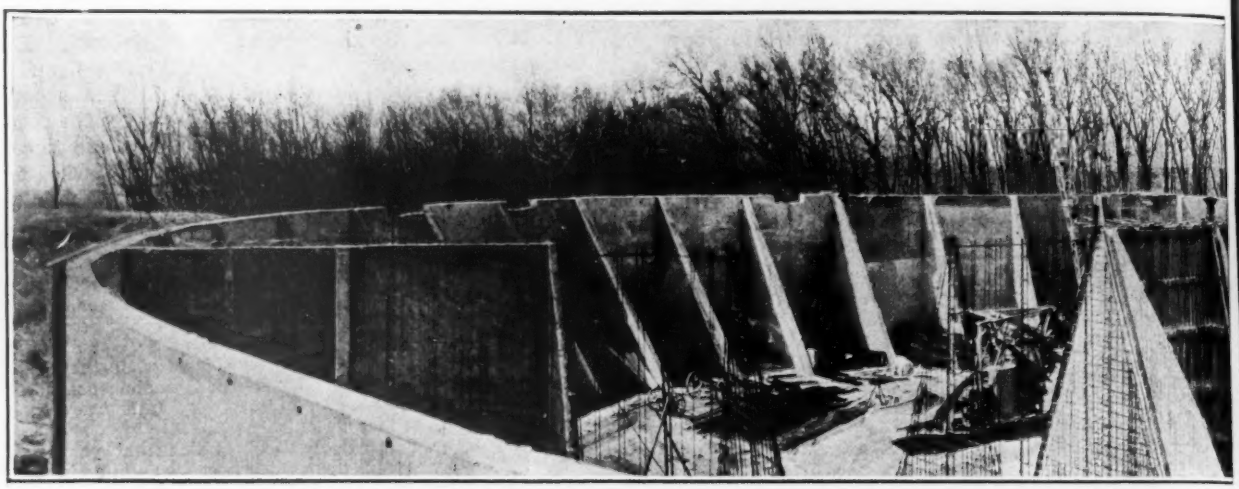


FIG. 1—CIRCULAR REINFORCED-CONCRETE RESERVOIR OF 6-M.G.D. CAPACITY, WITH

Design—The range of pressure was limited to approximately 10 lb. per sq.in. and the net water height in the reservoir was fixed at 25 ft. With a capacity of 6 m.g. this is equivalent to 10,000 gal. per sq.in. on each side, and is an easily remembered ratio. This condition fixed the necessary area at 32,000 sq.ft. For economy a circular reservoir 205 ft. in diameter was adopted.

Three types of construction for the circular shape were considered: (1) the ring, (2) the buttress, and (3) the counterfort type, the last being adopted. The ring type was eliminated because the amount of form lumber and concrete materials as well as mixing and placing equipment necessary for pouring at one time was excessive. The buttress type was eliminated because the topography of the site necessitated an excavation varying from 6 to 32 ft. in depth and a considerable extra quantity of earth would have to be removed for the buttresses and footings. The counterfort type was selected as the excavation would be a minimum, and this type can be built very easily in sections. It has the further advantage of being well adapted to the use of integral forms. The general design and details of expansion joints and other features are shown in Figs. 2 and 3.

A partition wall through the center insures circulation of the water in storage, and eliminates the necessity of reverting to the direct-pressure system whenever cleaning or repairing is necessary. This wall is of the counterfort-buttress type, as this is most economical for a wall which must withstand pressure from each side. The outside walls are vertical, with a batter of 8 in. on the outside face, the thickness being 24 in. at the bottom and 16 in. at the top. The counterforts are 12 in. thick. The width of the wall footings was designed to prevent overturning of the outside wall when the reservoir is full, making no allowance for backfill, and full upward pressure of 25-ft. head through the floor. The outside and partition walls, including counterforts, were divided in sections approximately 50 ft. in length, as such a section contains about 120 cu.yd. of concrete and can be poured easily in a working day. The end counterforts in each section were 16 in. thick, of which 8 in. was poured with each section, notches being made by using 2x4-in. timbers in the face of the first half poured to prevent slippage. All sections were designed as separate units.

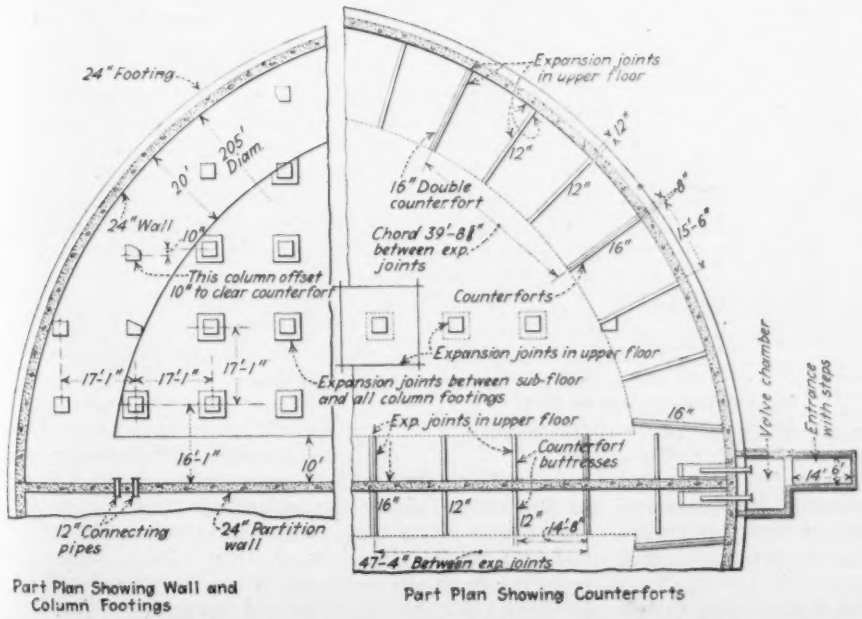
To provide for expansion, a bent copper strip was embedded in the sloping face of each double counterfort to cover the joint between sections. Its section was curved to provide the excess metal necessary, and its location was such as to allow inspection at any time from the inside. A galvanized-iron strip 4 in. wide was set on edge in the footings under the center of the outside and partition wall, and embedded in the wall to prevent leakage. Notches were also left in the wall

footings. The walls were doubly reinforced, the steel being 3 in. from the water face and 2½ in. from the dry face in every case. Through wiring of forms was not permitted.

The roof was designed to carry 200 lb. per sq.in., and the flat slab type was used as it was found to be most economical. This slab was 9 in. thick, reinforced four ways, with an additional 20 per cent of steel in the outside panels. Columns of 24-in. diameter were spaced in the form of a grid symmetrical about the center of the partition wall, and no spans exceeded 17 ft. 1 in. c. to c. The roof was anchored to the partition wall, but simply rested on the outside walls so that expansion could occur without creeping. Capitals and pads were placed upon top of the columns, and step-type column footings were used, separate from the floor (see Figs. 3 and 5. The 6-in. sub-floor contains sufficient steel to prevent the outside walls and footings from being pushed out, no allowance being made for friction or for the earth backfill. On top of this floor is a waterproof membrane of tar and paper upon which is the 3-in. top floor, the joints in the two floors being staggered.

To prevent washing in case of leakage, a 5-in. vitrified pipe drain was laid under both edges of the footings of the outside and partition walls. This drain was laid with open joints in gravel and all leads were carried in the discharge manhole separately, so that if leakage occurs it can be determined which quarter is leaking and whether it is through the floor or walls. To facilitate drainage and cleaning, the floor was given a slope of 1 ft. along the partition wall. Two ventilating houses are provided, one at each end of the partition wall. Each house has a manhole opening for each side. A slot was left in the top of the partition wall for an overflow and a 20-in. overflow pipe was provided through the outside wall. Inlet and discharge connections are of cast-iron pipe, so arranged in an outside valve chamber that either or both halves of the reservoir can be used. Check valves provide that all the water enters one side and is fed from the other side, thus insuring circulation.

PARTITION WALL ON CENTER LINE, BUILT FOR WATER SUPPLY OF MADISON, WIS.



Part Plan Showing Wall and Column Footings

Part Plan Showing Counterforts

FIG. 2—PART PLAN OF NEW REINFORCED-CONCRETE RESERVOIR AT MADISON

Construction Work — The grading involved 20,000 cu.yd. of cut and 13,000 cu.yd. of fill, with 3,150 yd. of haul. This work was done with a steam shovel and by teams with dump wagons and graders. For the concrete work (5,145 cu.yd.) the quantities and unit prices were: 1,870 cu.yd. in footings and floors, $12 per cu.yd.; 1,987 cu.yd. in walls and counterforts and 345 cu.yd. in columns and panels, $17; 943 cu.yd. in roof, $22; 506 tons of reinforcing steel, 4c. per pound. The sand and gravel was specially graded for this work and the cement was tested by the Wisconsin

Highway Commission. Batches were hauled to the job and dumped into the mixer hopper. After mixing for 1½ min. the concrete was discharged into a steel hopper-bottom bucket with bottom opening and conveyed by a crawler-crane to its place in the forms. Fig. 4 shows the concreting plant, with the crane placing a bucket load of concrete.

Reinforcing steel in the walls was held in place by ladder frames made of 2x2-in. angles and straps 1x⅜ in. These ladders were made to fit the batter of the walls and notches were burned in the edges to receive the horizontal bars.

Bolts to hold the bottom of the frames had been embedded in the footings. Wood forms for the walls and counterforts were built in sections and moved by the crane. The outside wall forms were shaped to the proper curvature by using horizontal 6-in. channels, properly bent. To these were bolted 3x10-in. vertical planks. Counterfort forms were built in rectangles and then sawed diagonally to make two side forms, using two planks spiked together to make a T section. On these were placed 4x4-in. sticks set in adjustable shores and supporting timbers 8x10-in., across which were placed 2x12-in. planks on edge. These planks were leveled up by the use of the adjustable shores and the 1-in. roof boards were put on. Cross bracing prevented swaying. Wall and counterfort forms were held in place by form ties made of bolts, rods, cones and collars, so arranged that forms could be accurately spaced. After pouring, the collars, cones and end bolts were removed, leaving the spacer bolts embedded in the walls, 1½ in. beneath the surface.

FIG. 4—CONCRETING THE RESERVOIR WALL
Motor truck delivering batch to mixer. Revolving crane on crawler is placing a bucket of concrete at the form.

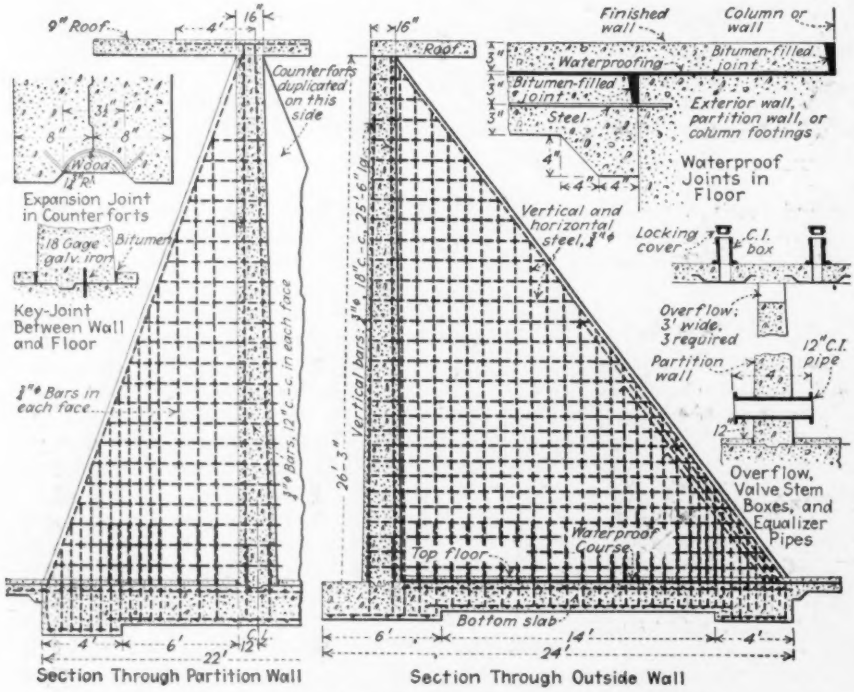


FIG. 3—WALL AND FLOOR DESIGN OF CIRCULAR RESERVOIR

Finally, the inside and outside surfaces of all the walls and the counterforts were given a ¾-in. coat of gunite to cover stony places, to fill the holes left by removing form-tie cones, and as a further precaution against leakage.

When completed, each half of the reservoir was washed and cleaned. Chlorinated water was used in filling and bacterial analyses were made of the water. After the water had been pronounced safe by the city Health Department the reservoir was put into service in December, 1926. There were two moist spots on the walls, and a small leakage through the floor, neither of which caused concern.

Designers and Builders—The design and construction

forms. Each set of outside wall forms for one pouring consisted of three outside and three inside forms and six counterfort forms. The partition wall forms were constructed of the same material but were made without curvature.

Sectional steel column forms were assembled to full length, as shown in Fig. 6, with the steel spirals and rods inserted, and were poured by use of the crane and bucket. The roof forms were built as a trestle with supports spaced 6 ft. c. to c., beginning at a distance of 3 ft. from column centers. The bottom half of each support was made from plank salvaged from the wall

of the reservoir were under the direction of the writer, as superintendent of water-works. For the design of

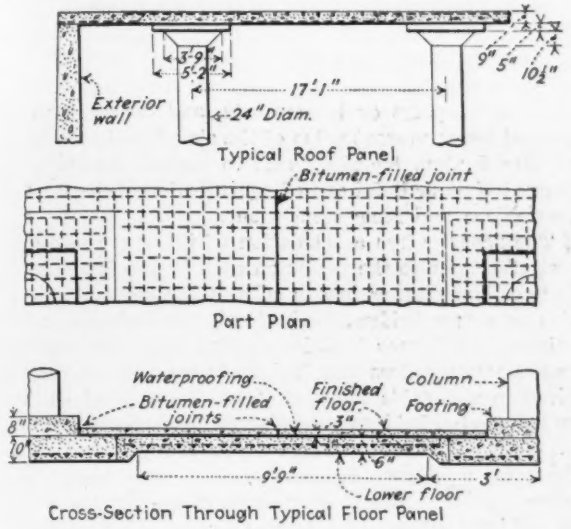


FIG. 5—DETAILS OF FLOOR COLUMNS AND ROOF SLAB

the concrete structure, the Water Department engaged J. Glaettli, Jr., formerly an instructor in concrete design at the University of Wisconsin, and the plans were

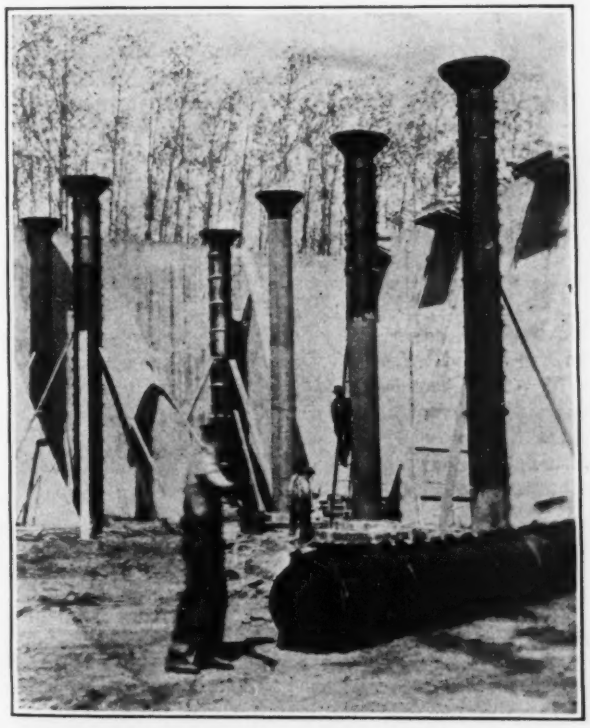


FIG. 6—COLUMN FORMS FOR MADISON RESERVOIR

Sectional steel forms were used. Reinforcement of columns consisted of steel spirals and rods.

approved by E. E. Parker, city engineer. E. L. Nordness, construction engineer of the Water Department, was in charge of the general investigations and of the construction work. The contractors were J. F. Icke, for the grading, at $10,637, and O'Dea & Shafer for the concrete work, at $123,000.

Operating Results at Iron Removal Plant at Memphis, Tenn.

By F. A. Mantel,
Chemist, Water Department, Memphis, Tenn.

THE municipally owned water supply of Memphis, Tenn., is at the present derived from 29 new wells, pumped by air-lift from a central station. The underground water contains objectionable amounts of iron, carbon dioxide and hydrogen sulphide, for the removal of which purification works were placed in service in June, 1924. A description of these works,

TABLE I—AVERAGE ANALYSES OF WATER FROM TWO GROUPS OF WELLS AT MEMPHIS, TENN.

	Temp. C.	pH	Free CO_2	H_2S	Dissolved Fe	Alkalinity	Hardness	Total Solids
500-ft. wells	17.3	6.4	33.6	Tr.	0.57	60.6	42.0	81.3
1,400-ft. wells	21.6	7.2	6.4	0.0	1.40	85.2	11.81	112.3

together with the preliminary operating results and a bibliography, were given by Wellington Donaldson in *Engineering News-Record*, Dec. 18, 1924, p. 992.

Since the new works were placed in service the city has augmented the supply by seven deeper wells, (1,400 to 1,460 ft.), in addition to the 22 wells, 350 to 530 ft. deep, existing in 1924. The deeper wells are an innovation, the water from which differs materially from that of the upper stratum, as is indicated by Table I. It will thus be seen that with increasing depth, there is an increase of temperature, iron, alkalinity, alkali carbonates and total solids, while carbon dioxide, hydrogen sulphide and hardness decrease materially. The deep wells supply 46.5 per cent of the total.

The changing composition of the underground water has not affected in any noticeable way the operation of the purification works, and the iron removal has been virtually complete at all times since

TABLE II—OPERATING RESULTS, MEMPHIS WATER TREATMENT PLANT, 1924-27

	1924 (6 mo.)	1925	1926
Water handled, m.g.d.	14.795	14.101	15.477
Filters:			
Final loss of head, ft.	8.6	7.6	7.1
Number of units washed per day	2.4	2.3	2.3
Average run between washings, hr.	73.2	80.4	77.3
Per cent wash water	0.63	0.67	0.68
Free CO_2—p.p.m.:			
Aerator inlet	33.5	29.1	22.0
Applied to filters	8.3	6.5	4.1
Filtered	7.7	6.0	3.6
Total iron (Fe)—p.p.m.:			
Aerator inlet	0.75	0.71	0.61
Applied to filters	0.60	0.55	0.51
Filtered	0.03	0.03	0.03
Operating cost of aeration and filtration plant (18.4 per cent of total plant operation cost) p.m.g.	.....	$3.34	.....

the new works were placed in service. Operating data for the past 2½ years are given in Table II. The CO_2 in the ground water, assumed to be 120 p.p.m., is largely removed by air-lift pumping and is further reduced by the coke aerators in the aeration plant.

The 1926 Typhoid Honor Roll

Four of the largest cities of the United States had not a single death from typhoid fever last year, according to the 1926 typhoid survey of the *Journal* of the American Medical Association contained in its issue of April 9. These were Albany, Utica and Yonkers, N. Y., and Youngstown, Ohio. Thirty-one other cities, making 35 in all, stand on the year's honor roll with less than 2 deaths per 100,000 for the year.

State of Washington Moves to Abolish Toll Bridges

Act Provides for Toll Regulation and Paves the Way for Public Ownership—Separate Act for Portland Interstate Bridge

THE right to acquire toll bridges by purchase or by condemnation was given to the state of Washington and to its counties by an act passed at the recent session of the legislature of that state. The act repeals all previously enacted state laws under which toll bridges have been built, requires owners of toll bridges to submit to the department of public works an annual report on their revenues as well as costs of repair, operation and maintenance, and provides for the regulation of tolls collected on such bridges.

A report covering five existing toll bridges, giving recommendations relative to their purchase by the state and, in cases where purchase is advised, stating the amounts that can economically be paid, was made to the legislature by a committee of four which included the state highway engineer. This report was submitted some months before the passage of the act referred to above. Another act passed at the same session of the legislature also follows the recommendation of the report in the matter of opening negotiations for the purchase of one of the five bridges, namely, the one across the Columbia River between Vancouver, Wash., and Portland, Ore.

The general act first referred to in the foregoing declares that "the highway policy of this state shall be that all public highways within the state shall be free and open for travel and that the state shall hereafter regulate all tolls collected for use on any toll bridge on any state highway." It authorizes the state to take over toll bridges after legislative appropriation for the acquisition of such bridges has been made, and similar authorization for purchase is also given counties but without the proviso that requires an advance appropriation.

The report of the committee of four on existing toll bridges now operated under franchise by private parties was made in accordance with an act of the legislature passed in 1925. This act asked for data about toll bridges as follows: (1) The date of construction, cost, probable life, present value and replacement value; (2) the cost of maintenance and rate of tolls charged on such bridges, the volume of travel thereon and the probable future volume of travel thereon; (3) the probable sums necessary to be paid by the state for the purchase of said bridges from the several owners and any other related facts that the committee considered material.

The five bridges covered specifically in the report are the Pasco-Kennewick bridge, the Pasco-Burbank bridge, the Metaline Falls bridge, the Nasel River bridge and the Vancouver-Portland bridge. Data on each of these structures are presented separately in the report arranged as follows: (a) History and description of project; outline of organization of company if privately owned; (b) type and design of structure, including load-carrying capacity as compared with present-day standards, etc.; (c) awarding of contracts, supervision, construction, records and final cost of structure including quantities of materials entering structure, promotion, right-of-way, etc.; (d) traffic conditions covering past, present and probable future traffic together with schedule of tolls and estimate of past, present and probable future income; (e) probable life of present structure; cost of maintenance and cost of necessary repairs or betterments, and depreciation to present time; present value of the structure to the state of Washington, including cost to replace structure at present time or build one of equivalent usefulness; (f) conclusions and recommendations.

The report gives a tabulation of the average yearly cost of service to the public on each of the five bridges in question, placing in one column the costs of operation as a free bridge and beside it the costs for a toll bridge; the former includes sinking fund and interest and the latter does not include taxes. From figures given in this table it appears that the cost of service on private toll bridges operating on the highway system of Washington ranges from 63 to 185 per cent more than the total cost to the state for maintaining the same service if the bridges were owned by the state. Of the total amount of tolls collected by private owners, 15 to 27 per cent was spent for the collection of tolls and other incidental expenses due to the fact that the bridges were operated as toll bridges.

Other reasons pointed out as arguments against the continuation of the toll bridge plan were: (1) Interest on money borrowed by the state does not exceed 5 per cent as compared to the 7 or 8 per cent paid by private corporations. (2) Because the success of a toll bridge depends largely on investment in the roads leading to it, a privately owned toll bridge capitalizes the investment in the public highway system. (3) The greater cost of toll bridges as compared to bridges built by state or county increases the operating cost and hence the burden on the traveling public.

The act authorizing acquisition of part interest in the interstate highway bridge across the Columbia River so as to transfer interest and control in the structure from Clark County to the state of Oregon, provides that this purchase shall not be consummated until an agreement with the Oregon joint owners of the bridge has provided that it shall be maintained and operated without tolls on privately owned vehicles. The price that may be paid for the acquisition of these interests is not stipulated but is left to the discretion of committees designated to handle the matter.

Cross-Connections Cause Outbreak in England

Cross-connections between the municipal and an industrial water-supply system have been held responsible for an outbreak of "zymotic diarrhea" in the Borough of Poplar, England, last July, according to a report of the Ministry of Health, summarized briefly in the London *Surveyor* of May 6, 1927. The regular supply is furnished by the Metropolitan Water Board of London. Most of the cases of illness were located on a road opposite the works of the Metropolitan Gas Co. These works are supplied not only from the metropolitan works but also from the River Lea "which," the *Surveyor* says, "is obviously polluted at this point." There were "several cross-connections guarded by valves; and the pollution was caused by polluted water being forced back into the board's mains, which have now been disconnected."

New 12-M.G.D. Water Purification Plant for Oakland

Aerator, Mechanical Alum Mixer, Joint Coagulating and Settling Basin, Single Filter Operating Stand and Wash Water Reclaimer

THE ADDITIONAL 12-m.g.d. water purification plant for Oakland, Calif., just put in use by the East Bay Water Co., has as its main features a 105-nozzle aerator, mechanical alum mixers, a choice between three methods of operating the coagulating and settling basins, large filter units, but divided and operated in half; a single operating table for the eight half-filters; and reclamation of wash water. In size, the new plant, which treats water from the 16-m.g. Upper San Leandro impounding reservoir, duplicates the earlier plant built to improve the quality of the water from the 14,000-m.g. San Pablo impounding reservoir of the company. In design, the new plant embodies improvements based on operating experiences and full-scale tests made at the old plant. Since the design for the new plant was made by the organization that will operate it, every detail of arrangement was worked out with a view to operating economy and efficiency, resulting in a high degree of flexibility combined with great simplicity of control. Economy in first cost was aided by the use of nothing but standard parts and fittings.

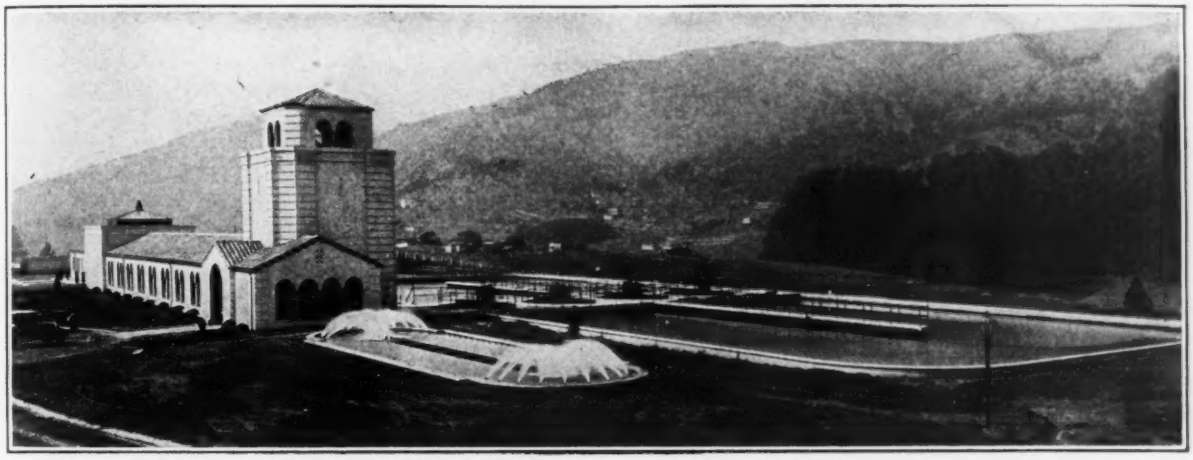


FIG. 1—GENERAL VIEW OF WATER PURIFICATION PLANT, WITH AERATOR IN FOREGROUND
Only part of the nozzles of the aerator are in operation in this view. See detail in Fig. 2 and view Fig. 3.

The general layout of the plant is shown by the small plan while the larger plan and developed section show the routing of the water from the aerator through the alum mixing tanks, the joint coagulating and settling reservoirs, the filters and to the clear water reservoir. The elements of the plan will be described in succession.

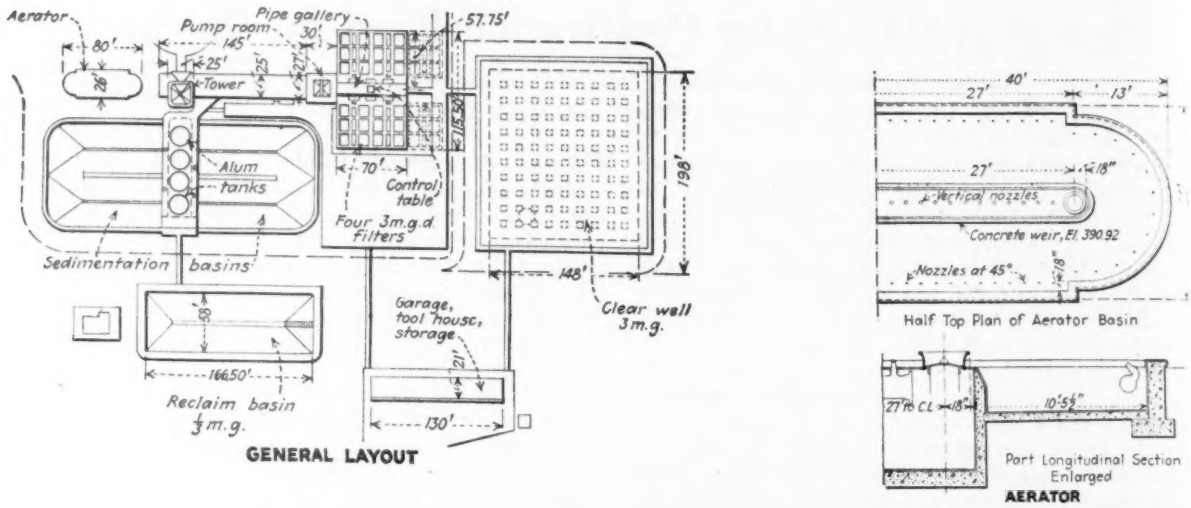
Aerator—Water from the impounding reservoir, near by, passes to the aerator which consists of 105 2½-in. nozzles in an oval concrete basin. The jets along the axis of the basin are vertical and those around the rim are set at an angle of 45 deg. For architectural effect, the water level is close to the ground surface, with only the tips of the nozzle projecting.

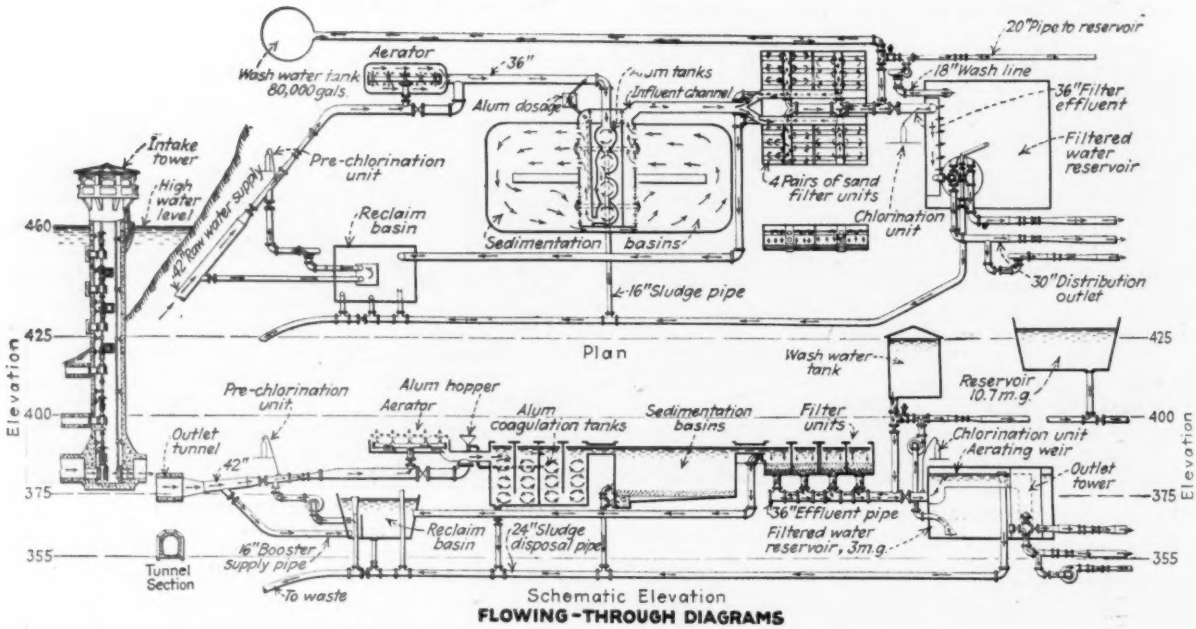
Chemical Feed and Mixing—The aerated water is dosed with sulphate of alumina by means of dry-feed machines, in duplicate. The dosage is varied to suit the condition of the raw water which is subject to sudden and marked changes in turbidity, contains appreciable amounts of colloidal coloring matters, and sometimes has a high algal content. The coagulation units are of the type developed for the filtration plant at Sacramento, Calif. (see *Engineering News-Record*, June 2, 1921, p. 924). The process of dosing by the use of circular tanks connected in series was patented by Wilfred F. Langelier, associate professor, sanitary engineering, University of California.

Instead of the usual baffled mixing channel or chamber, there are used four circular concrete tanks, 21 ft. in diameter and 21 ft. deep, each tank equipped with a variable-speed motor-operated stirring mechanism which imparts a swirling rotary motion to the water. The diameter of these tanks was kept down to a minimum to avoid too wide a range in velocity and to simplify the design of the operating mechanism. By keeping the gear ratio on the driving motor down to 50:1, standard apparatus could be used. The paddles are designed to operate at variable rates, and the water velocities as high as 3 ft. per sec. may be developed.

To conserve head and more particularly to avoid excessive turbulence, the inlets and outlets of the coagulating tanks were made unusually large. The connecting passageways or flumes are all rectangular and the numerous openings which afford connection for all possible operating combinations are controlled by means of stop logs. These stop logs are interchangeable and as there is usually no appreciable difference in head on opposite sides and since the routing of the flow is not changed frequently, this type of control has been found to be simple, efficient and inexpensive. The total loss of head in this part of the plant, from the aeration basin to the water level in the sedimentation basins, with the plant running at a rate of 13 m.g.d., was 2 inches.

Coagulating and Settling Reservoirs—The combined coagulation and sedimentation basins have been designed





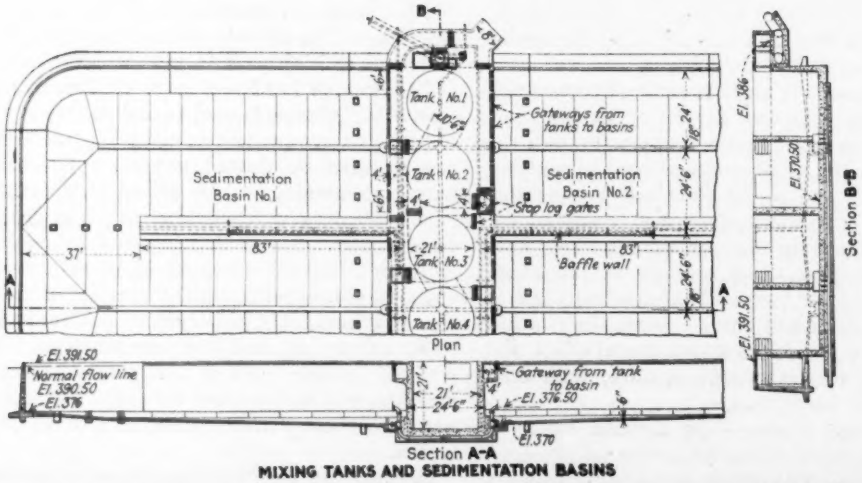


FIG. 2—LAYOUT AND SEQUENCE OF OPERATIONS OF SAN LEANDRO PLANT FOR OAKLAND WATER SUPPLY

to permit unusually flexible operation to meet wide variations in the character of the raw water. In the split-dose system, the water passes in series through two coagulating tanks, thence through one sedimentation basin, in series through the other two coagulating tanks, and finally through the remaining sedimentation basin. In the single-dose, parallel operation, water flows in series through all four coagulating tanks and thence through the sedimentation basins in parallel. In the single-dose, series operation, the water passes in series through all four coagulating tanks, thence through the sedimentation basins in series. Coagulation and sedimentation can continue with either sedimentation or coagulation basins out of service.

Each basin has a holding capacity of 1 m.g. and is

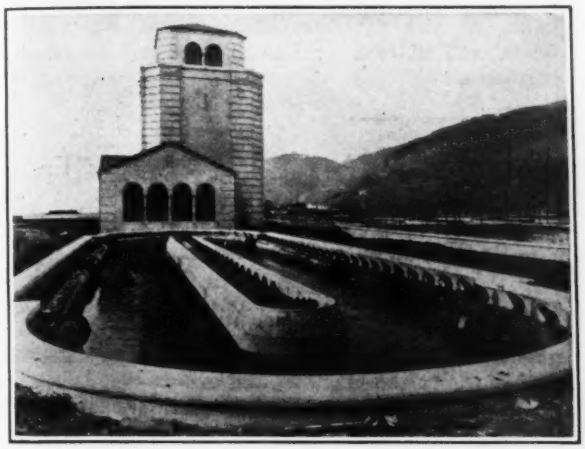


FIG. 3—AERATOR BASIN SHOWING NOZZLE ARRANGEMENT AND CENTRAL CONTROL WEIR

provided with a longitudinal baffle that causes the flow to follow the shape of the letter U, with either end available for inflow or outflow. The openings into this basin, which are at surface level, are made very large so as to prevent disruption of the flow. A sloping bottom leading to a suitable valve connection provides for sediment removal.

Filters—The filters operate under 8- to 15-ft. head, at a rate of 110 m.g.d. per acre instead of a more common 125-m.g.d. rate. The use of relatively large filter units was made feasible by dividing each unit into halves, so arranged that either half could be washed separately. Since the rate of wash-water application is approximately six times the normal rate of filtration, the combined effluent of three double units is sufficient to wash one-half of the fourth unit. In addition to greater simplicity, analysis indicated that the bifurcated units result in a considerable saving in first cost, more particularly in the equipment required for supplying and reclaiming the wash water.

Each filter unit has eight hydraulically-operated valve or gate connections. By keeping the number of filter units down to four, as compared to the usual 8 or 12 for a plant of this capacity, it has been possible to centralize the control of all of the 32 gates at a single operating table. From this table, which is immediately over the center of the pipe gallery, there is a clear view of all the filter units and practically the entire pipe gallery.

Experience at the earlier or San Pablo plant has shown that air agitation preliminary to the water wash

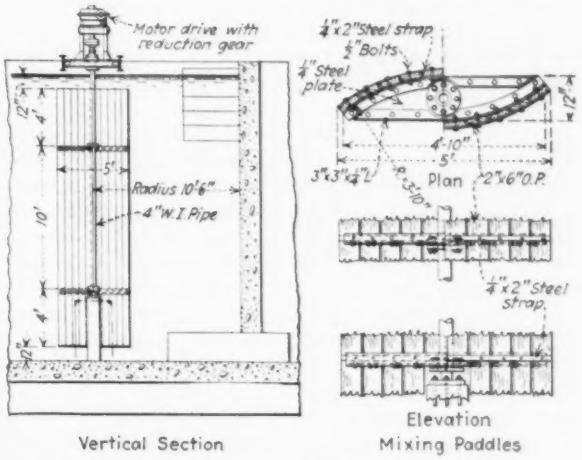


FIG. 4—DETAILS OF ALUM MIXING TANK

of the sand is highly desirable because of the manganese content of the raw water which forms a sticky hydrate not easily removed and which tends to make the sand plastic. This adhesive quality makes the sand liable to crack under water; also, in the ordinary washing without some preliminary agitation to break up sand incrustation, the wash-water is likely to develop

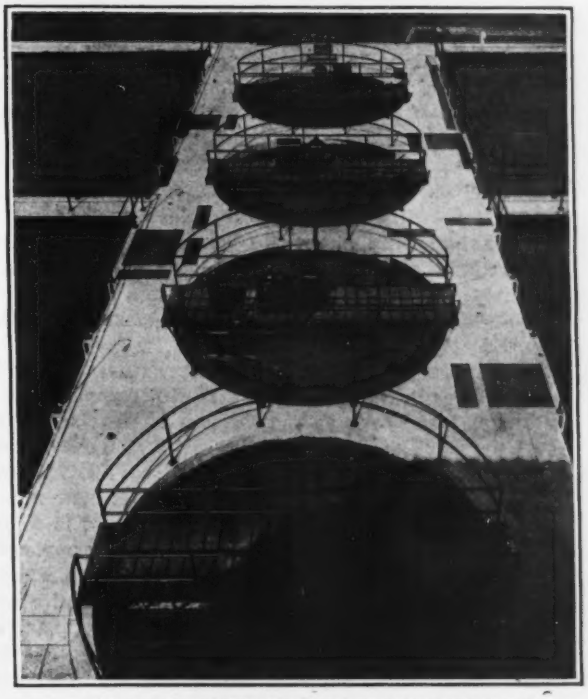


FIG. 5—LOOKING DOWN ON THE COAGULATION BASINS FROM THE PLANT TOWER

and follow certain channels leaving considerable blocks of the sand with the impurities undisturbed. A discussion of this condition appeared in *Engineering News-Record*, April 3, 1924, p. 565. As a result of this experience, suitable provision for air agitation of the sand has been made in the design of this new plant.

Perforated red brass tube underdrains were selected as most suitable for this plant. Experiments showed that this type of underdrain, if laid perfectly level,

would satisfactorily serve for the proper distribution of air. The underdrains are 3 in. in diameter, set on 9-in. centers, and perforated with ⅜-in. holes on 6-in. centers.

Experience with these local waters indicates that approximately 3 per cent of the output of the plant will be required for washing the sand units. A suitable "reclaim" basin serves as a sump from which the soiled wash water may be returned to the raw water supply.

Designers of the plant take particular pride in the arrangement and connections within the pipe gallery in which are located all of the valves and control apparatus for the operation of the filters. Most of the valves in this gallery are hydraulically-operated, and the location of the pipe lines along the side walls leaves the central aisleway clear for inspection, repairs, etc., and there is ample direct daylighting through the two large openings in the floor above.

Centering on a single control table or operating stand are the operating mechanisms which include eight connections for each filter unit. These consist of valves whose functions are indicated by the following markings: "Influent," "Effluent," "Rewash," "Waste," "Wash Water" and "Air Wash"—these last two are operated in conjunction with the other two valves marked "Right" and "Left," referring to the half of the unit into which these connections lead.

Chlorination—Local experience having demonstrated the effectiveness of pre-chlorination, provision has been made for this and for admitting chlorine to the water later on, also. Chlorine is bought in one-ton drums instead of 150-lb. containers, thus saving in cost and lessening interruptions in continuity of dosing.

Designs for the new plant were prepared by the engineering staff of the East Bay Water Co. under the direction of G. H. Wilhelm, vice-president and general manager, with Charles Gilman Hyde, Raymond E. Davis, and Wilfred F. Langelier acting as advisory engineers.

Dragline Mucking in Rock Tunnel for New Chicago Intake

Hand Mucking Replaced by System Using Cable Buckets Delivering to Loader Platform Over Spoil Car Tracks—Gain in Speed and Economy—Drilling and Mucking Alternate

CHICAGO is building a new water intake tunnel to improve supply conditions in the northern half of the city. The present work covers 3 miles of this tunnel, but 12 miles of extension is projected. It is in rock, at about 150 ft. depth below water, with 40 to 60 ft. of rock cover. The section is of horseshoe form, 13 to 16 ft. in equivalent diameter. Construction of the tunnel has developed a number of interesting and novel features. Chief of these is a dragline mucking system with elevated loader platform which discharges the spoil directly into cars below. This system has produced a marked gain in speed and economy over hand mucking. It was developed by the engineers of the city water department, who are constructing the tunnel by force account.

On the accompanying map Fig. 2 the new tunnel is indicated by heavy dash lines. It will extend from a new crib just north of the Carter H. Harrison crib, southwestward to the Two-Mile crib, and thence westerly to Chicago Ave. The Two-Mile crib, built 1865-67, is the earliest of the city's crib intakes and now is too near shore to give a satisfactory supply. It is to be put out of service when the new tunnel is completed, the supply for the three present intakes from the crib then being provided by way of the new tunnel from deeper water. Another purpose of the new tunnel is to permit abandoning the land portions of the Northwest tunnel, which supplies the Springfield Ave. and Central Park Ave. pumping stations from the Carter H. Harrison crib. The lake section of the Northwest tunnel will be retained, and will discharge by a short connecting tunnel into the land section of the new Chicago Ave. tunnel, whose extension to the pumping stations in the western part of the city is to be undertaken as soon as practicable. Accordingly the new tunnel has different sizes of cross-section (Fig. 1).

While the necessity of increasing the water supply is the prime reason for the construction of the new intake crib and tunnel, one of the factors in the background of the situation is an important change of policy on the part of the city's water authorities in recent years. Formerly the practice was to build supply tunnels to the pumping stations on diagonal alignment, passing under private property without regard

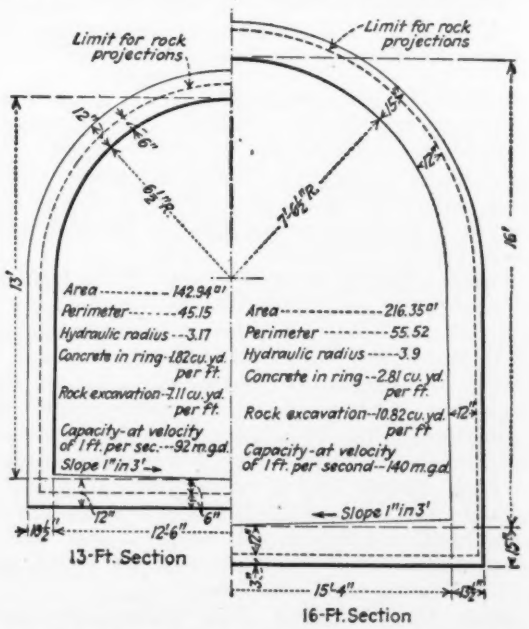


FIG. 1—CROSS-SECTIONS OF CHICAGO AVE. INTAKE TUNNEL

to the surface ownership. This has led to trouble in some cases and has been declared trespass. While diagonal tunnels are more efficient than tunnels following the street lines, the probable cost of securing easement under private property led to the decision to locate all future water tunnels under streets and to provide

for the earliest possible replacement and abandonment of existing diagonal tunnels. The Northwest tunnel is

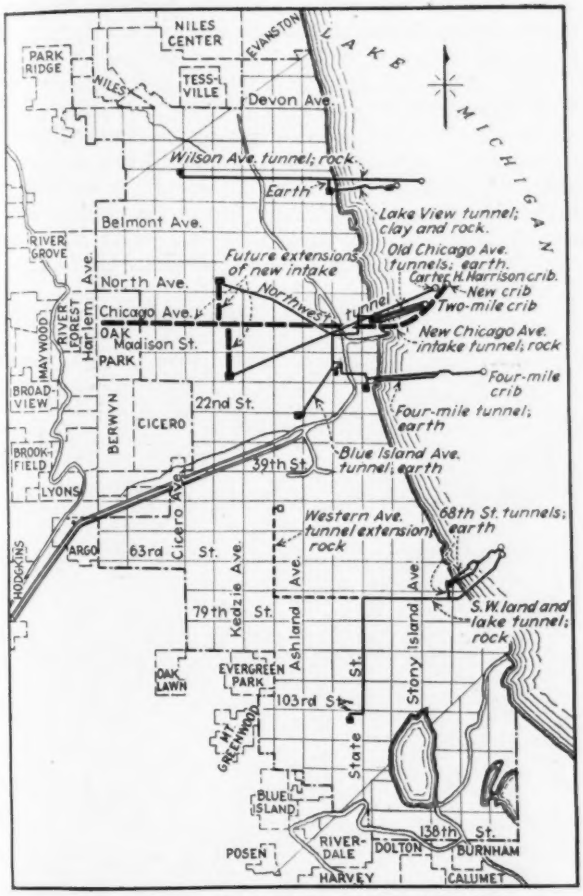


FIG. 2—MAP OF CHICAGO WATER INTAKES

the only diagonal tunnel left, and the necessity of replacing it by a street-line tunnel according to this program was a factor in determining on the Chicago Ave. tunnel program.

In the earlier practice of the Chicago Water Department, the supply tunnels were constructed in earth (mainly clay), at a relatively moderate depth (60 to 80 ft.). Along the lake shore rock is at a depth of about 100 ft., though it rises to the west and nears the surface at or beyond the city limits. For the past twenty years the city's policy has been to locate all its water tunnels in rock, for permanence and security from deterioration or disturbance. The Southwest tunnel, commenced about twenty years ago, was the first of the main intakes excavated in rock throughout. The Wilson Ave tunnel, 8 miles long, completed 1918, was next. A later instance is the Western Ave. tunnel, a 6-mile extension to the Southwest tunnel, recently completed. The Chicago Ave. project follows these precedents.

The rock is a horizontally bedded limestone, generally firm and watertight, though greatly varying in stratification and structure. It permits tunnel excavation under the most favorable conditions—virtually complete absence of water—with only occasional trouble from rock sufficiently broken to require timbering or from soft pockets. Compressed air is not required, and most of the excavation is unsupported. The finished tunnel, of course, is lined with concrete.

Construction of the Chicago Ave. intake was begun from a shaft sunk within the breakwater surrounding the Two-Mile crib. Headings were started in both directions. A land shaft was sunk later just inside the shore line. The spoil taken up the crib shaft was dumped overside at the crib, for subsequent removal by dredging and deposit along the toe of the government breakwater.

Difficulties in Sinking Land Shaft—The land shaft had to penetrate about 125 ft. of soft ground before reaching rock. It was intended to be constructed as a reinforced-concrete cylinder built up and sunk as excavation inside progressed. At a depth of about 90 ft., however, the resistance to sinking became so great that no further progress could be made. Excavation was continued unlined through a depth of about 19 ft. of hard clay, with the expectation that this work could be carried down to rock. Before rock was reached, however, a layer of soft ooze was encountered.

Stoping had been started upward from the tunnel, and when about 12 ft. of the ooze had been penetrated and lagged a shot in the stope collapsed the bracing. In order to save the work this portion was immediately filled with sand. Fifteen feet of shell was then built on top of this sand, leaving a space of 4 ft. between

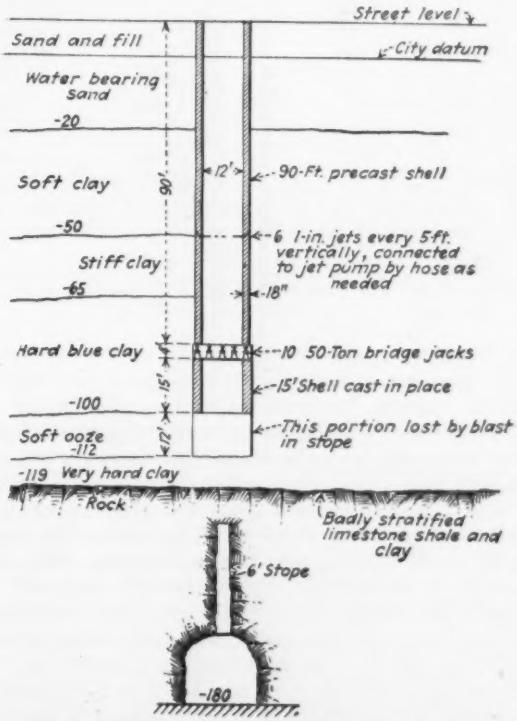


FIG. 3—METHOD OF SINKING SHORE SHAFT

its upper edge and the bottom of the 90-ft. shell sunk from the surface (Fig. 3). In this space ten 50-ton bridge jacks were placed, and using the upper shell as an anchor the lower 15-ft. shell was forced down through the ooze stratum until it reached hard clay, when the usual sinking was resumed.

Tunnel Excavation—The conventional top-heading-and-bench method is used in all of the headings. The

bench is short, its face being kept within 25 to 35 ft. of the heading face. When the heading is shot, part of the breakage goes over the face of the bench, and both heading and bench muck piles are conveniently within reach of the mucking machine. The rounds are about 10 ft. long. The arrangement of holes and sequence of firing are normal.

One of the most troublesome features of the work from the beginning was the high wage rate of the muckers and the necessity of hiring them as "60-day men" because nearly all are non-citizens not eligible for civil service examination. In the attempt to reduce the mucking cost and troubles, a small air shovel and later a larger electric shovel were tried, but the experiments were not successful. The machines were not of sufficient capacity and the difficulty of bringing up cars singly and loading them caused too much delay.

The construction engineers of the water department then conceived the plan of mucking by dragline bucket, the bucket being operated from and discharging upon an elevated platform fitted with hatches which could load an entire train of cars in one operation. The system as first worked out is substantially that now in successful use, except for the type of shovel used. Several shovels or buckets bought in the open market were first tried, but later a 2-yd. bucket designed by the construction engineer's staff was built, and this proved far superior to the others in digging power, in manageability, and in endurance. The present form of bucket is sketched in Fig. 6, and its rigging is indicated in the sketch of the mucking plant, Fig. 7. The front of the bucket is attached to the hauling line by a bridle connected to top and bottom of the front of the bucket, while the outhaul line is attached to a ring in the middle of the upper rear edge of the bucket. The rear lower edge is fitted with six manganese-steel teeth bolted to reinforcing strips integral with the back wall or bottom of the bucket. The width of the bucket is 6½ ft., which enables it to command half the width of the tunnel from one position of the outhaul sheave.

The mucking machine consists of a traveling loading platform with inclined chute up which the full bucket is hauled. The top of the traveler platform is a flat trough 7 ft. wide edged with 10-in. steel channels set with web vertical; the trough is lined with sheet steel and has its bottom formed into a succession of shallow hoppers each equipped with a two-leaf hatch or gate. The gate levers are connected by cables to an operating cable through which all the hatches of the machine are opened or closed simultaneously. The substructure of the traveler is of gantry form and straddles the loading track, which is laid on the center line of the tunnel and branches by switches into the two tracks (inbound and

FIG. 4—TOP OF MUCKING MACHINE
View toward tunnel face. Bucket with load has just come up the incline and is being hauled back along the trough to discharge the spoil. Hatches in foreground.

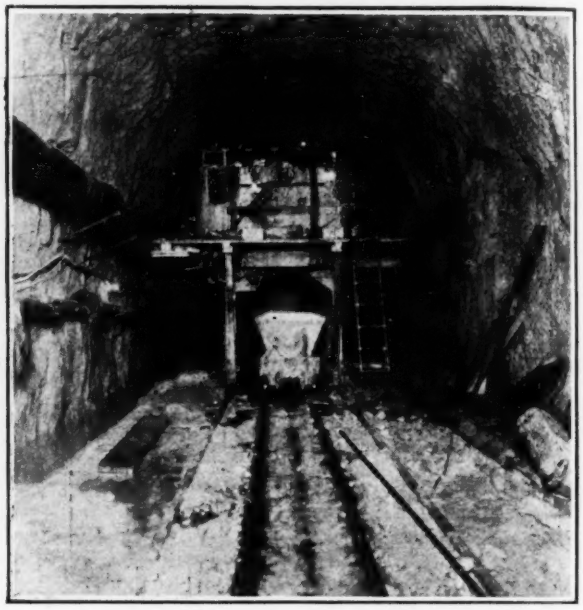


FIG. 5—MUCKING MACHINE FROM REAR
Spoil brought by bucket into the trough formed by the deck of the machine is discharged into 1-yd. cars below through hinged gates, each car being filled by a single discharge.

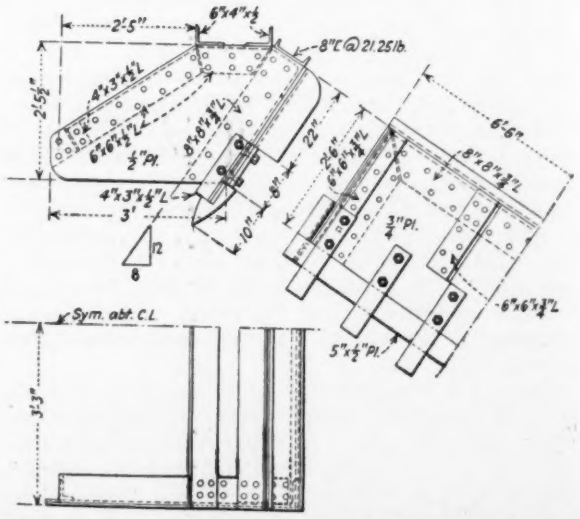


FIG. 6—FINAL FORM OF SCRAPER BUCKET FOR MUCKING OUT ROCK TUNNEL

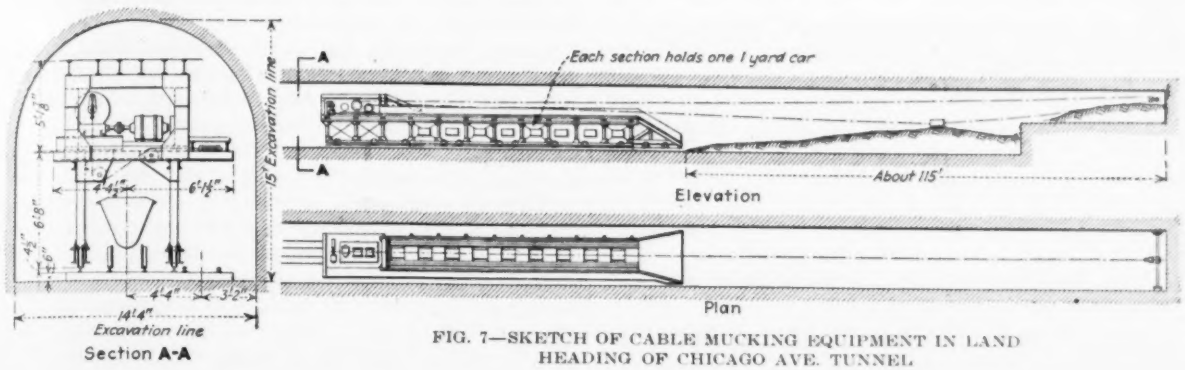


FIG. 7—SKETCH OF CABLE MUCKING EQUIPMENT IN LAND HEADING OF CHICAGO AVE. TUNNEL

outbound) a short distance back. On the rear end of the traveler deck a two-drum electric winch is mounted for operating the bucket lines, an auxiliary electric winch for operating the hatch doors of the platform, and small air hoists for handling empty and loaded cars to and from the traveler by means of cables anchored to the tunnel wall.

The traveler is stationed 110 to 200 ft. back of the heading face. Hooks for the forward sheave of the scraper line are wedged into holes drilled at the top of the heading face on either side, and in the side wall 3 or 4 ft. above bench level and in line with the bench face. After the round has been shot, holes are drilled for these hooks, the sheave is attached, and one side of the heading is mucked out. The bucket carries some of the muck over into the bench muck pile but moves most of it up onto the loader platform. Then the sheave is shifted to the other heading hook and the second half of the heading muck pile is cleared out. Where necessary to cover the full width, the sheave is also set in the middle position by swinging it from a bridle attached to the two hooks. After this, clearing the bench muck is handled similarly, the sheave being attached to a bridle rope stretched between the hooks in the side walls.

The pockets in the deck of the traveler are so proportioned that when full to the top of the bucket trough they hold just one carload. The winch operator controls the gates from his stand and discharges the pocket burden into the cars at the right time. While the trough is being filled, full and empty trains are handled in and out of the double track by a separate crew.

While excavating the 13-ft tunnel section with hand mucking, an advance of 12 ft. per shift was made, producing 160 one-yard cars of muck per shift, which was loaded out by a crew of 30 muckers. With the mucking machine in the 16-ft heading, a crew of 10 men handles 230 cars of muck per shift.

The operations are carried on continuously during the 24 hours, as follows:

7 a.m.	muckers down
12 noon	miners down
7 p.m.	muckers down
12 midnight	miners down

In this way the mucking shift always has the bench clean when the next shift of miners is ready to go in, and the miners are through shooting when the next mucking crew arrives.

The work was carried on under the supervision of John Ericson, veteran city engineer of Chicago until his death a month ago. At present it is under Major Myron B. Reynolds, assistant city engineer. Mayor William Hale Thompson, Commissioner of Public Work Richard W. Wolfe, and Deputy Commissioner Edward F. Moore are the city officials in charge.

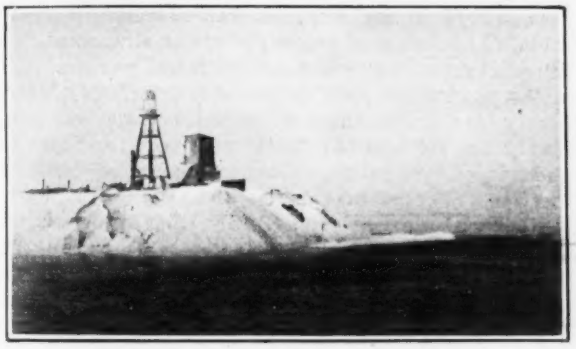


FIG. 8—DUMPING SPOIL FROM TWO-MILE CRIB, FOR SUBSEQUENT REMOVAL BY DREDGE

FitzGerald Art Collection Sells for $192,000

The portion of the art collection of the late Desmond FitzGerald which was sold at The American Art Galleries in April brought $192,000: paintings, $139,000, Korean and Chinese pottery and porcelain, $34,000, and etchings $19,000. A small Winslow Homer water color, "The Portage," brought $15,700, a record amount for water color. Three Monets, a Renoir and a Sargent also sold for large amounts. Nearly half the etchings were by Frank W. Benson; of these, 190 brought nearly $18,000 and one of them $1,125.

Geneva Conference Comes to an End

Special Report from the International Economic Conference, by E. J. MEHREN, Vice-President, McGraw-Hill Publishing Co.

Geneva, Switzerland,
May 9, 1927

THE plenary sessions of the International Economic Conference included the speeches most eagerly awaited—those by Henry M. Robinson, head of the American delegation, by the Russian delegates Sokolnikoff and Obolenski-Ossinski, by W. T. Layton, editor of the *Economist* and member of the British delegation, and by Monsieur Loucheur of France.

It was an interesting group: Robinson, calm, judicious, gracious; Sokolnikoff, astute; Obolenski-Ossinski, so much of a youth as to appear out of place in this conference of mature men, but challenging with communistic doctrine the economic structure of all other nations represented; Layton, carrying all with him through the incisiveness and convincing character of his analysis and deservingly earning the most prolonged applause in the four days' sittings; Loucheur, the only real orator in the four days, pleading, cajoling, defending, appearing from his manner to be saying a great deal more than he did.

Robinson Speaks for America—What would be America's view of the various proposals was the constant query of the first two days; and when it came none could want a clearer statement than Mr. Robinson's. The American believed that the actual level of tariffs is less of a barrier to trade than lack of stabilization of tariffs, abrupt changes in duties, lack of definiteness in classification and terminology. In maturing methods for mitigating those difficulties the conference might help.

The American delegation, he indicated, would not oppose the international cartels idea as such, but would disapprove government participation in them and insist that they must not exploit the consumer. He sketched briefly and clearly the development of the American industrial system and accounted for our present prosperity by improvements made in management practice, by elimination of waste, by lavish use of machinery and full interchange of information on production and trade methods. He indicated that the tendency of management now was to secure needed economies by bettering its practice, eliminating waste and introducing more and better machinery rather than by wage reduction.

Relations between employers and workers are quite happy; both groups subscribe to the doctrine of more effective production as the basis of prosperity, while every enlightened self-interest urged them to continue developments in the same general direction.

Russia Speaks—But if Mr. Robinson received close attention the interest was intensified when Sokolnikoff arose. Delegates massed solidly around the tribune to catch every word. What would a new social order say to the old? What message did the Union of Soviet Republics have for the capitalistic world?

But there was disappointment. There was only one message for the capitalistic world: "Come and trade with Russia. We welcome foreign capital. The capitalistic and communistic social systems are different but they can work together."

Sokolnikoff having failed to reach expectations, rumor soon had it that his colleague, Obolenski-Ossinski, head of the delegation, would fire the hot shot. And he did. He raked the capitalist system fore and aft, accused it of anomalies, of causing the World War, of impotence to handle the economic situation effectively.

Even the most ardent apostle of "capitalism rampant" had to admit that some of his criticism caught chinks in the armor of capitalistic states, though he failed to carry conviction that communism's armor was free from flaws, or that the communistic system had handled or could handle the present economic situation more effectively. He cited, for example, the discrepancies in the well-being of the workers of different nations, the large unemployment in certain countries, the over capacity of industry, the discrepancy between production and consumptive power, the lengthening of working hours even where there is unemployment, and the discrepancy between the returns of agriculture and industry. He doubted the effectiveness of international cartels and while he pleaded for co-operation of the communistic and capitalistic systems he intimated that their co-existence was only temporary, possibly implying that one of the systems was doomed to disappear.

As a transitional plan he suggested eleven steps for the re-establishment of trade: (1) Cancellation of war debts, (2) increase of wages of industrial workers, (3) introduction of the eight-hour day for all workers, with six hours in mines and "similar industries," (4) fullest liberty for trade union organizations and complete liberty for strikes, (5) "real" measures for relief of unemployed, (6) raising of unemployed relief funds by taxation, (7) decrease of unproductive expenditure, particularly in armaments, (8) abolition of all barriers against emigration and immigration, (9) cancellation of all systems of protectorates and mandates and recognition of rights of all peoples to self-determination, (10) suspension of all measures of intervention in China, and (11) suspension of all measures of economic boycott against Russia and re-establishment of relations with her so that she can obtain credit needed for her development, the capitalists in turn securing concessions.

Layton's Searching Effort—An outstanding effort was that of Mr. Layton and the audience was quick to respond to his searching analysis and clear and convincing exposition. He pointed out that, despite the recovery of European production in 1925 to 104 per cent of pre-war and trade to 94 per cent, there were 10,000,000 men out of work. But it was false, he maintained, to strive to return to the pre-war status. A new status, a "new equilibrium" is needed, due to the following new conditions:

(1) The great increase in industrialization in all countries—a continuation of tendencies visible before the war but much accelerated by the conflict.

(2) The development of the United States into a creditor nation, but under conditions different from that of previous capital exporting nations; for while Great Britain, for example, as an exporter of capital, had had a surplus of imports, buying goods from countries she financed, the United States was taking steps to keep out the products of countries she was helping to develop or restore.

(3) Alteration in emigration.

(4) Alteration of trading relations, due to settlement of reparations and international indebtedness arising out of the war. Debtors had to develop an export surplus and creditors to accept an import surplus.

(5) The large shrinkage in Russian trade.

(6) Division of Central Europe into small economic and political units. New tariff walls to the length of 11,000 km. have been erected, there has been a large waste of capital through duplication of plant as between these countries and a reduction in volume of trade between the fractions of the old Austro-Hungarian empire and between them and contiguous countries, making necessary difficult trade divisions and adaptations.

He declared that plans to meet the new conditions must be based on these fundamental, but very simple, principles:

(1) The interdependence of the nations of Europe is so close that their economic prosperity must rise or fall as a whole; no nation in the long run can be prosperous through its neighbors' misfortunes.

(2) Material well-being can be achieved only by economic production; permanent prosperity will never be achieved within by industries or by communities which pursue a policy of trying to make profits by restricting production.

(3) Europe can keep abreast of industrial progress only if her economic organization permits specialization, not merely between businesses but between nations. This requires substantial reductions in existing tariffs, so that the tide of international trade may flow in greatly increased volume.

Geneva, Switzerland (by cable), May 21, 1927

The recommendations of the conference, all of which had been approved by the committees, were given final approval in the general session May 17. The resolutions on industry cover rationalization, industrial pools and statistics.

The recommendation on rationalization, that is, the application of all devices for reducing costs, urged that labor should co-operate to secure good working conditions and a fair share in the results. It also advised occupational selection, guidance and training for labor. There was further recommended a national and international standardization program for materials, parts and products to facilitate international trade, and the education of manufacturers' workers regarding advantages of rationalization was urged.

Disagreement was quite general on national and international industrial pools. They were believed to be good or bad, according to results and their regard for the general interest. Their field of application is limited to branches of production already centralized and to products in bulk or of recognized grades so that cartels alone are not able to remove European troubles. Where they are applicable, however, they secure more methodical organization of production, reduce costs through better utilization of existing equipment and develop new plants along better lines. Such group undertakings more rationally check uneconomic competition, reduce evils of fluctuating industrial activity and thus assure greater stability of employment. They also reduce production and distribution costs, making for lower selling prices and thus benefit the consumer. However, if pools encourage monopolistic tendencies and the application of unsound business methods they may check technical progress and corporate dangers for the public. They must not injure either the consumers or the workers nor restrict the supply of raw materials or basic products to any particular country.

The control of national agreements by an international judicial scheme is impossible. However, national legislation can control the operations of an international agreement in home territories, although voluntary recourse to arbitral bodies is desirable. The League of Nations should study international industrial co-operations and their effects upon technical progress, production and labor prices and should publish such data.

On industrial statistics, the conference recommended that international statistics be compiled on the supply of raw materials, on output, stocks, prices, wages and employment. It recommended a standardization of terms, methods and scope, and to begin with the basic world industries and those raw materials in which world shortage is anticipated.

The resolutions on commerce condemn export and import prohibitions and special privileges granted to state enterprises. The conference recommended a liberal policy toward foreign nationals and companies engaged in commerce and urged a simplification of customs and tariffs and a standard nomenclature. The stabilization of tariffs by means of long-term treaties, referring chiefly to European countries, was also recommended. The conference declared that hampering tariffs should be reduced, starting with those imposed to counteract the effects of war disturbances. It was recommended that the exportation of raw materials be not burdened by export duties and that such duties where necessary should not discriminate between different countries.

All direct and indirect subsidies to home industries were condemned and dumping was declared harmful, out of all proportion and a temporary advantage from cheap imports.

The agricultural recommendations were based on the fact that agriculture is the occupation of a majority of the world's workers and that the maximum industrial development is determined by the quantity of food and raw material which they produce. It was declared that equilibrium must be re-established between returns to industry and agriculture. Low farm purchasing power has reduced the demand for industrial products and the fear was expressed that unless a balance is restored decreased agricultural production will be detrimental. Welfare-making remedies suggested are a general adoption of a scientific organization of production, technical improvement and marketing, standardization of agricultural products and better credit systems.

Because American public opinion is opposed both to governmental participation in industry and to monopolistic tendencies, American delegates stated that while not opposed to resolutions on industrial pools they would abstain from voting thereon. There was no criticism or animosity to America and no evidence of a European combine against America. The contribution of American delegates was much appreciated for they took the position that they were here to help give the data requested regarding our experiences but not to tell Europe what to do.

New Methods in the Water-Works Field

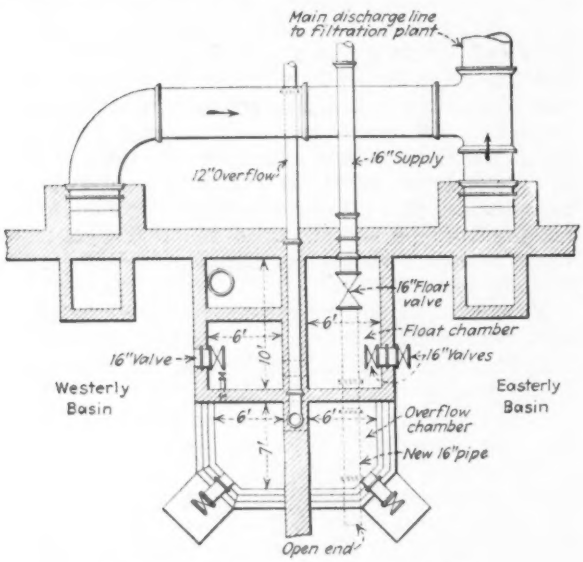
What the Engineer Has Developed in New Technique and Practices

Wash Water Reservoir Control at Cleveland, Ohio

By L. A. Marshall
Assistant Superintendent, Water Purification and Sewage Disposal, Division of Water, Cleveland

CHANGES MADE in the float chamber of the wash water reservoir at the Cleveland, Ohio, filtration plant eliminated trouble experienced with an altitude valve which controlled the elevation of the water in the reservoir.

Water used for washing the filters at the division filtration plant is drawn from a 400,000-gal. covered concrete reservoir consisting of two rectangular basins located on a hillside above the plant at an elevation of about 60 ft. above Lake Erie. The reservoir is filled



CHANGES MADE IN FLOAT CHAMBER

through a 16-in. cast-iron pipe line, direct-connected to a 48-in. low pressure distribution main. The 16-in. line discharges into the float chamber through an altitude float valve. From the float chamber the water passes through two 16-in. hand-operated valves into the reservoir.

The disturbance created by the discharge through the float valve into the relatively small float chamber caused irregular and rapid movement of the float and the jamming of the pilot valve. Bolts on the lever arm also were sheared off. These difficulties resulted in the main valve sticking in either an open or closed position, resulting in the reservoir overflowing or emptying. The 12-in. overflow line proved inadequate to carry the discharge off and often the grounds and buildings below the reservoir were damaged before hand valves could be closed.

The changes necessary to remedy this condition could not be made without shutting the plant down and could not be made until October, 1925, when the entire plant was shut down. The changes made consisted in carrying a 16-in. pipe line from the discharge end of the float valve through the dividing wall between the wet chamber and the dry overflow chamber, then through another wall into the easterly basin of the reservoir.

By this arrangement the discharge from the 16-in. line through the float valve is carried directly into the easterly basin of the reservoir. The elevation of the water in the reservoir is transmitted back into the float chamber through the two 16-in. valves opening from the east and west basins of the reservoir and the equalization of the water level in the two basins through the two main discharge lines. The water level in the float chamber now rises and falls more slowly and no trouble has been experienced with the float valve since the change was made.

Ground Water Used for Flushing Sewers

By Alexander Potter
Consulting Engineer, New York, N. Y.

IN constructing a sewer system, supervised by the writer, for the borough of Keansburg, New Jersey, most of the sewers were laid below ground-water level in coarse sand which permitted the development of a flushing manhole using the ground water instead of the municipal water supply. This not only avoided the waste of water due to leaking flushing siphons but handled the problem of sewer flushing in an economical manner.

Because of the very flat terrain, minimum grades of sewer were made necessary with the resultant minimum velocities. Not only was the designer confronted with these conditions, but the borough had no sewerage service whatsoever, so that it was expected that some time might elapse before a sufficient number of house connections were in operation before quantities of sewage were contributed which would be large enough to maintain continually the minimum velocities. These conditions made flushing practically mandatory. A large manhole was constructed and around the outside were placed several well-points which in turn were surrounded by gravel in order that they might function as efficiently as possible. The invert of the sewer and the manhole bottom being well below the ground-water level, permitted the ground water to enter the manhole through the well-points which were piped through the walls of the manhole. A tide flap-gate was constructed to prevent the passage of the water into the sewer. The water in the manhole rose to the elevation of the ground-water table and fluctuated sufficiently to prevent stagnation. Periodically, the sewer maintenance forces were expected to visit the manhole, raise the flap-gate and hold it open until the ground water which had accumulated passed down the sewer. The tide flap-gate then being released would fall back in place and prevent the

ground water from entering the sewer until the next visit of the sewer maintenance force.

One precaution necessary is that no means should be provided to hold the flap-gate in the raised position, otherwise the ground water would continually flow into the sewer at a rather slow rate without any flushing value. When the flow in the sewers becomes sufficient so that they are self-flushing, the well points may be capped, and the flap valve removed.

Use of Ejectors on Alum Sirup Dosing Lines

By Harry N. Jenks
Associate Professor of Sanitary Engineering, Iowa State College, Ames, Iowa

At the Sacramento pumping and filtration works the coagulant is manufactured by the Hoover process and the alum sirup is measured directly from the digestion tanks by means of a cast-lead dipper wheel, driven by a variable speed mechanism which operates at a rate proportional to the amount of water being filtered. The 32 deg. Bé. liquor, a solution containing approximately 45 per cent of $Al_2O_3(SO_4)_3.18H_2O$, is lifted into the measuring device by an air-operated lead-lined ejector; while the discharge from the measuring wheel is received into the suction opening of a second ejector, the operating water for which combines with the sirup to form an alum solution of ordinary strength. This is forced by the ejector through cast-iron dosing lines to any of a number of points of application to the water to be treated, as indicated in Fig. 1. The use

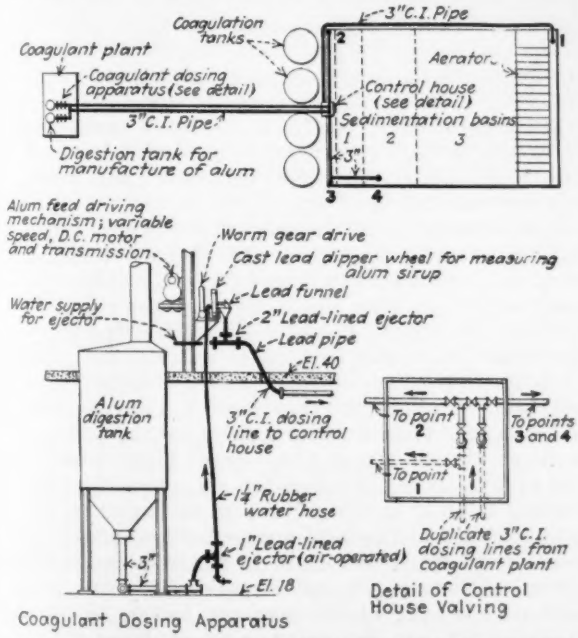


FIG. 1—DOSING SYSTEM, SACRAMENTO FILTER PLANT

of the dipper wheel for measuring the sirup, and of the ejectors for conveying the alum solution, has solved all difficulties due to corrosion and wear of ordinary feeding devices, and in addition has proved to be most economical in first cost and operation.

In filtration plants, as at Sacramento, where it is desirable to apply the coagulant at one or more points in a single or divided dose, the ejectors enable the alum to be delivered relatively long distances in a closed system of piping, which, with suitable valving, permits of flexible operation. Referring again to Fig. 1, it may be noted that the following useful schedules of dosing are possible:

Schedule	Point	Location	Method of Application	
A	1	Preceding aerators	Primary	Divided dose
	2	Preceding coag. tank 1	Secondary	
B	2	Preceding coag. tank 1	Single dose	
C	3	Preceding sed. basin 1	Single dose	Coag. tanks bypassed
D	2	Preceding coag. tank 1	Primary	Divided dose
	3	Preceding sed. basin 1	Secondary	
E	2	Preceding coag. tank 1	Single dose	Double coagulation
	4	Preceding sed. basin 2	Single dose	

The distance from the water-operated ejectors in the coagulant plant to the most remote point of application

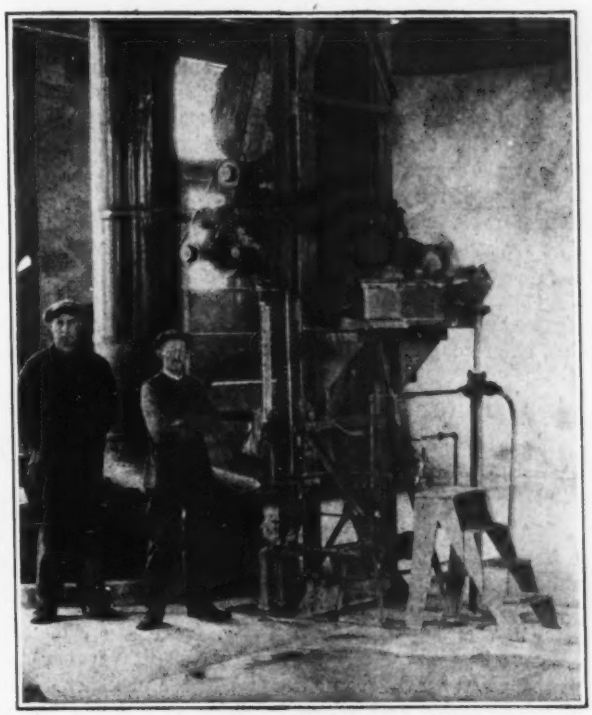


FIG. 2—DOSING MACHINE FEEDING ALUM SIRUP

(1) is about 700 ft. Each ejector is capable of discharging 25 g.p.m. against the friction head of the 3-in. pipe shown in the sketch. No deposition occurs in the dosing lines, although the alum sirup contains considerable gritty matter comprising the sludge from the digestion tanks. The ratio of alum sirup to ejector water varies from 1 to 10 per cent, equivalent to an aluminum sulphate solution range of 0.5 to 5 per cent.

To raise the alum sirup from the digestion tank to the measuring wheel, the air-operated ejector, shown in detail in Fig. 1, is placed below the bottom level of the tank, since with air the ejector will not operate satisfactorily with suction lift. With alum sirup of 32 deg. Bé. (10.65 lb. per gal.) experience shows that a 1-in. ejector will discharge 2 g.p.m. of the sirup against a total head of 22 ft. when supplied with air at 50 lb. per sq.in. pressure. The amount of air used is very small and may be controlled by cracking a ¼-in. needle valve. In a Hoover alum plant, as air is employed to keep the sludge in the digestion tank in suspension, it is available at little additional cost for operating the ejector.

A view of the alum feeding mechanisms in the coagulant plant, showing the measuring wheels, is shown

in Fig. 2. The location of the water-operated ejectors that discharge the measured alum sirup into the dosing lines may also be observed. At each revolution the wheel dips up from the flow box a definite quantity of alum sirup; the excess sirup that may be discharged into the box by the air-operated ejector is returned to the digestion tank through an overflow weir and hose. The total alum fed per unit time is determined by the r.p.m. of the measuring wheel.

A lead-lined ejector is recommended for use with sulphuric acid and similar corrosive liquids. Much experimenting with different kinds of pipe convinced the writer that for lines up to 2 in. diam., chemical lead or 3- or 4-ply rubber water hose should be used. It is not necessary to employ the more expensive chemical hose. For pipes 3-in. size and above, high-grade cast iron is satisfactory for the dilute solutions, but should not be used for alum sirup unless lead-lined. It was found that cast iron specials, particularly, are subject to rapid corrosion by the concentrated alum liquor; and because of the difficulty of lead-lining these fittings, it is preferable to use a special non-corrosive material.

The features of design, involving the use of a measuring wheel and ejectors, were devised by the writer while superintendent of the Sacramento plant; and the equipment was detailed and installed by Charles Lundelius, chief coagulant plant operator.

Filter Plant Operation in a Small Community

By Nicholas S. Hill
Consulting Engineer, New York, N. Y.

A SMALL filter plant was recently constructed at Bethel, Conn., which has certain features of design permitting minimum attendance. The plant was constructed at a cost of about $20,000. A small section of the town was supplied by gravity from a shallow reservoir. The water was safe from a sanitary viewpoint but was unsatisfactory because of the presence of iron, color, tastes and odors in objectional amounts. Aeration followed by coagulation and filtration, treating the water with sulphate of alumina and soda ash, was the obvious remedy, with the location of the treatment plant at the reservoir, which was situated about 2½ mi. from the town.

Having a supply which for years had cost little or nothing to maintain, the proposition to install and operate a filtration plant at this distance from town was not appealing. Fortunately the cost of chemicals was small and it was possible to design the plant so as to make the amount of attendance a negligible factor. This was accomplished by providing ample filter capacity, large chemical solution tanks and a filtered water basin with a capacity equal approximately to one day's consumption, which permitted flexibility in the attention required and allowed the plant to be operated intermittently at uniform rates.

The operation of the plant is controlled by the elevation of the water in the filtered water basin. Float valves are provided on the raw water inlet, filtered water effluent, and on each outlet to the orifice tanks for the chemical solutions. These floats are in a small chamber which fills when the water overflows the top which is placed at the high water level in the filtered water basin and drains by the opening of a float-controlled valve when the water lowers to a predetermined level, ranging from 6 in. to 15 in. below high water. This method of control permits operation at a uniform rate with all valves full open and eliminates many of the difficulties experienced with low rates of flow when an attempt is made to control automatically by throttling.

The operator, who is the superintendent, visits the plant twice each day to wash the filters, prepare new chemical solutions or make any adjustments found necessary. In case of fire there is ample reserve storage to allow time for the operator to reach the plant and readjust the rates and should the fire be of major intensity exceeding 500 g.p.m. for two hours, provision has been made for bypassing the plant. The plant has been in successful operation since the first of the year producing a water of excellent character.

The coagulating basin provides four hours' detention at 100,000 g.p.d. rate of operation. The filters are in duplicate, each of 100,000-gal. capacity. The filtered water basin has a capacity of 50,000 gal.

New Methods in the

Removing Sand from Gravity Water Supply Line

By Robert B. Morse and Carl A. Hechmer
Chief Engineer and Department Engineer, Respectively, Washington Suburban Sanitary District, Hyattsville, Maryland

THE water filtration plant at Hyattsville, Maryland, which at present furnishes a small part of the water for the Washington Suburban Sanitary District, is fed through an 18-in. gravity supply line approximately 2 mi. long. This line is of vitrified pipe and is laid on the flat slope of 0.5 ft. per 1,000. Water is taken from the stream through several intake pipes and a screen chamber is effective in preventing leaves and sticks from entering the pipe line.

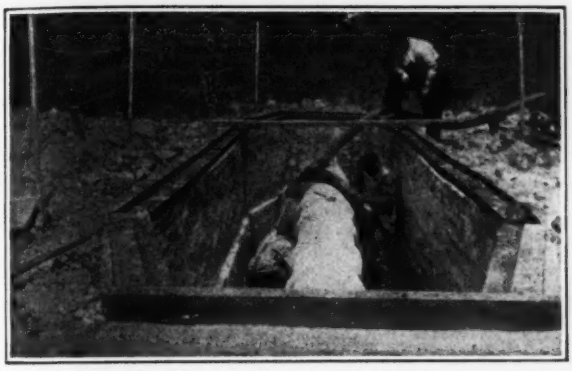
On account of the low velocity of flow, considerable difficulty was experienced in maintaining the supply line after it was placed in service in 1920, due to accumulation of sand in the pipe. This condition cut down materially the amount of water available at the filtration plant. The stream from which water is taken has a comparatively steep watershed and still drains much farm land. Turbidities range from 5 p.p.m. in cold dry weather to from 1,000 to 5,000 p.p.m. at times of excessive rainfall. During periods of high turbidity much sand is carried in suspension and enters the pipe. Attempts to build up the velocity of the water in the pipe line failed and manholes were built to allow the use of drag buckets and cable, to maintain maximum delivery. Cleaning required a period of about two weeks with a gang of five men and had to be done several times a year, depending on the condition of the water in the stream. Cleaning in freezing weather was especially difficult and the bucket method was expensive.

In the summer of 1924 a sand trap was constructed on the line at an available point some distance below the screen chamber. This trap is 24 ft. long and 6 ft. wide, converging at the ends to a width of 24 in. where the pipe enters and leaves. The bottom at the inlet end is 3 ft. below the invert of the pipe; at the outlet end it is 2 ft. below. This allows the sand to accumulate in the trap without interfering with the flow of water. The bottom was built of concrete and the side walls

Water-Works Field

of brick. The walls were plastered and very little leakage has occurred through them. As there was a single supply line leading to the Hyattsville plant, it was necessary to keep the pipe in service during construction of the trap. The excavation was made and the concrete floor constructed while the pipe line was held suspended by cable supported on beams across the hole. After the floor was completed, the pipe was supported by jacks placed underneath it and the side walls of the trap were carried up to the proper height. When the entire structure had been completed the section of line passing through the trap was removed.

This trap removes a large percentage of the sand. We clean the trap about once a month, the operation requiring the services of two men for two hours. The



SAND TRAP COMPLETED WITH PIPE STILL IN USE

supply line has been cleaned twice since the trap was installed and little sand was found in the pipe, roots at the joints necessitating the work on each occasion. The greatest advantage is realized in maintaining approximately maximum capacity of the supply line at all times. We clean the sand trap with long handled scoops without shutting off the water. The trap is covered with a wire net which keeps out leaves and allows an overflow during high water, thus preventing the formation of a pressure condition too heavy for vitrified pipe to stand.

Removing Sand from Well Water

By W. W. Brigden
Superintendent, Department of Public Works, Battle Creek, Mich.

IT HAS appeared to the writer that the ordinary plan of installing a well system in fine sand, using 4 to 10-in. pipes for casings, with air lifts or vertical centrifugal well pumps discharging directly into the distribution pumps is wrong. This plan permits sand and other material to be carried into the pumping equipment, making repairs necessary and, in addition, decreasing the efficiency of the equipment.

A method used which avoids this difficulty is to pump by air lifts or vertical centrifugal pumps into a basin of sufficient area and capacity to allow the sand and other substances to settle to the bottom of the basin. This deposit is then removed from the basin periodically or as it accumulates.

The basin should be arranged so that the water will flow along its entire length and the bottom should be sloped from the inlet to the outlet with a fall of at least 1 in. in 10 ft. It is also advisable to curve the bottom so that the center portion will be lower than the sides, permitting easy cleaning.

The pumpage from the wells should preferably be carried into the basin by gravity. Where the supply is secured from a number of wells, means should be provided for shutting off and turning on individual wells. Valves cannot be used, of course, where the air pipes of an air lift system pass down inside the well casing or discharge pipe, but if the air pipe goes down outside the casing, valves may be inserted. Although the air lift system has not been developed to a very high degree of efficiency, it provides a large volume and can raise water from greater depths where a high lift is required.

Improving Fire-Fighting Facilities in a Small Community

By D. E. Davis
The J. N. Chester Engineers, Pittsburgh, Pa.

THE desire to provide fire protection for the community is usually an outstanding consideration in constructing a water-works in a small village, but in attempting to keep costs down, there is a tendency to skimp in sizes of mains and to defeat the object sought. The method employed to improve the inadequate fire service in one small village may possibly be found advantageous to others similarly situated.

The village officials in a rural community of about 1,100 inhabitants had been informed by the fire underwriters that the insurance rates would be materially increased if measures were not taken towards improving existing conditions. The entire system was made up of 4-in. and 2-in. mains, served from a small pumping station, housing a triplex pump, which took its supply from a concrete reservoir. A second small reservoir was located at the upper end of the village, but as the static pressure from this reservoir, as registered at the center of the village, was less than 15 lb. it was of little or no use as a fire reserve.

The custom in the village had sanctioned the closing of the upper reservoir at times of fire by the operation of a gate valve, and the boosting of the pressure at the pump station. Fire flow tests, under this condition, showed a maximum delivery at the center of the village of 302 g.p.m., but with a residual pressure on the hydrant of only 11 lb.

The remedy of new and larger lines was practically out of the question because of the cost involved, as was also the purchase of a fire engine. After a little study a plan was evolved which met the approval of the underwriters, and which furnished sufficient water and fire pressure for the business district at a reasonable cost.

A small pumping station was erected beside the upper reservoir, in which was installed a motor-driven centrifugal pump of approximately 400 g.p.m. capacity at 125 lb. pressure. Water entered the pump directly from the reservoir under a slight head so that the pump was always primed, and the discharge was connected to the pumping main entering the reservoir. Between this connection and the reservoir a check valve was placed on the main, so weighted that it remained upon during normal operation but was automatically closed when the fire pump was in service. The pump was arranged for automatic starting from a push button station located

in the municipal hall as was also the pump at the lower station.

By this arrangement the upper reservoir was made available for supplying water for fire fighting, and as water was pumped under pressure from both ends of the system it was possible to more than double the delivery at the center of the village and to maintain adequate residual hydrant pressure.

Testing Proposed Ground Water Supply for Beatrice, Nebraska

By Harry P. Letton
Consulting Engineer, Lincoln, Neb.

THE PROBABLE yield of a proposed ground water supply for Beatrice, Neb., was recently tested by sinking a group of wells, pumping from one of them for seven days, measuring the discharge by weir and observing the lowering of the water in all the wells during pumping and the restoration of the levels after pumping ceased. The levels were determined by electrical apparatus.

Beatrice is a town with about 10,000 population, located on the Big Blue River, 40 miles south of Lincoln. Considerable difficulty has been experienced during the past 40 years in obtaining a satisfactory water supply. Several well supplies have been developed and later abandoned because of the depletion of the supply. For many years raw river water was used. The present supply is obtained from a well, 3 miles west of the city, producing about 0.75 m.g.d., which is considerably less than the summer demand. This well penetrates the Dakota sandstone and extends about 20 ft. into the underlying limestone. The water percolates from the sandstone into crevices in the limestone and through these reaches the well. About three years ago the question of the construction of a filtration plant for treating river water was voted on but the proposition was decisively defeated. Since that time considerable money has been spent in testing all available areas near the city but these tests have failed to reveal any but limited underground supplies.

During the past winter, tests showed that a plentiful supply can be obtained from the Dakota sandstone at a point about five miles west of the city. The sandstone at this location has an average thickness of about 40 ft. and is overlain with blue clay of about the same thickness. Under static conditions the water rises about 25 ft. above the top of the sandstone.

To test the probable yield from the proposed wells at the new location, 13 test holes were sunk, of which all but four encountered the sandstone. One of the test holes was made 12 in. in diameter to admit a pump cylinder. The other 12 were each 4 in. in diameter, located from 75 to 1,500 ft. from the pump hole.

Water level measurements were made by means of a length of rubber-covered wire fastened with friction tape to an ordinary 100-ft. steel tape. One end of the tape and the wire were rolled in sheet lead and soldered in place and the wire was then cut off even with the end of the tape, but insulated from it. A 45-volt radio "B" battery was connected to one end of the wire and the corresponding end of the tape, and an ordinary pocket voltmeter inserted in the circuit. When the weighted tape was lowered into the well the circuit would be completed as soon as it touched the surface of the water, causing a fluctuation of the voltmeter needle. Batter boards were set at known elevations at each test well and by means of a graduated rule the depth of the water level in the wells could be measured to 0.01 ft. This apparatus was kept continuously in place in the well being pumped while a similar apparatus was used to measure the water level in the other test holes.

After seven days of continuous pumping, the pump was stopped and the rate of replenishment was measured in the same way. As a result of the study of the well logs and the draw-down and replenishment curves, it is believed that a continuous minimum supply of 0.5 m.g.d. can be obtained from the area tapped and that from two to four times as much water could be obtained by increasing the number of wells and the area drawn from.

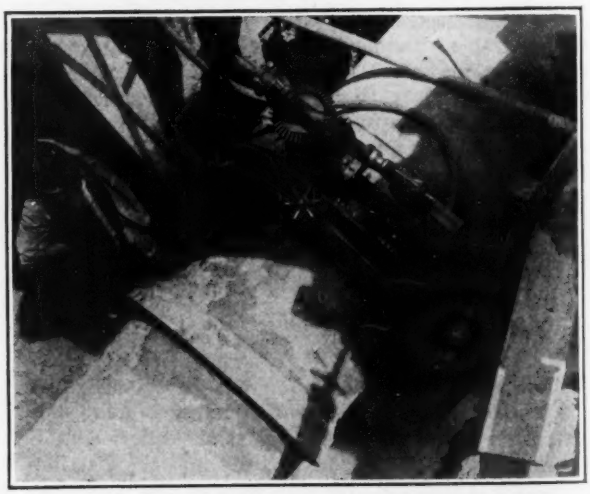
The tests were made under the direction of Grant, Fulton & Letton, consulting engineers of Lincoln, Neb., who have submitted to the city a report describing the tests and outlining the results obtained.

New Methods in the

Cutting Large Cast-Iron Pipes by Machine

By Chas. P. McGrath,
Superintendent of Yards Department of Water Supply, Detroit, Mich.

THE necessity for making a large number of connections between old and new cast-iron water mains of large diameter has resulted in the purchase, by the Detroit Department of Water Supply, of pipe-cutting machines ranging in size from 24 in. to 48 in. in diameter. The body of the machine is built in halves and centered on the pipe by means of set screws. A ring gear upon which two heads for the cutting tools are mounted, is bolted to the body, attaching to a machined groove in such a way that it is permitted to revolve around the circumference of the pipe. Power from a 2½-hp. air drill is transmitted to the ring gear through a series of bevel gears as shown. High-speed tool steel was used for the cutoff tools after carbon steel was found inadequate.



MACHINE CUTTING LARGE WATER MAIN IN TRENCH

Water-Works Field

Several advantages have developed from the use of these machines. One is a saving in time. It takes three men only 1½ hours to set up the machine on a 42- or 48-in. diameter pipe and one man from 30 min. to an hour to make the cut. Another desirable feature is the impossibility of cracking the pipe as is sometimes the case when cutting with diamond points. Still another advantage is the ease with which a section of pipe is removed from the trench, since the cutting edge of the tool is ¼ in. wide, giving a total clearance of ½ in. when considering the cuts on both ends of the removed section. Oftentimes three cuts are made in the trench and by so doing the piece of pipe required to sleeve-up the connection is cut.

Color Determination Practice at Minneapolis Plant

By Arthur F. Mellen
Filtration Engineer in Charge of Water Purification, Water-Works Department, Minneapolis, Minn.

OBSERVATIONS of the color of untreated water and control of the color of finished water are important in our work. If it is necessary to make color determinations at night it is impossible to secure readings by artificial light comparable to those made by daylight. This is particularly serious when changes in the treatment are made and it is necessary to know whether or not the water is properly responding. We have used for some time a bench type of daylight lamp which takes the guess out of the work completely so that we are as confident of these readings as though they were made during the day. This lamp is also used to advantage for residual chlorine determinations, colorimetric titrations and microscopical work.

Because of its importance particular care is given to color determinations, it being necessary to follow the progress of the color reduction during the treatment. Color readings in untreated turbid water, in coagulated water containing alum floc and in a properly filtered water present different problems. "Standard Methods of Water Analysis" states that, "Water containing matter in suspension shall be filtered before the color observation is made until no visible turbidity remains. If the suspended matter is coarse, filter paper may be used for this purpose. If the suspended matter is fine, the use of a Berkefeld filter is recommended." The use of filter paper is not at all satisfactory, it being readily seen that the results obtained depend upon the number of times the same paper is used. In some laboratories a new filter paper is used for each sample, the first 100 c.c. being wasted. This is a slow process in the case of coagulated samples and with untreated turbid waters will be satisfactory only if all colloids are retained.

If an untreated turbid water is filtered through filter paper and a portion of the same sample is filtered through a new Berkefeld filter, the latter will give materially lower color readings, showing that although no visible turbidity remained in the first instance, enough colloidal material was present but removed by the Berkefeld filter to make an appreciable difference.

We have used the army type of Berkefeld filter for color determinations for over eight years but are not thoroughly satisfied with this procedure. If the same sample of coagulated water is used, different results will be obtained depending upon the condition of the cylinders—whether a new one is used, or a used one has been brushed off recently, or if it has a coating of alum floc; the results being lower in the order named. It is apparent then that it is difficult to be sure that comparable results are obtained in the color determinations made day by day. We make a practice of brushing off the cylinder before filtering each sample, feeling that this approximates a true result.

We are now carrying on some experiments on preparing samples for color determinations by the use of a centrifuge which gives some promise of being a better procedure.

It is generally understood that it is desirable for a chlorinated water to have a reasonably long period of reaction before being delivered to the consumer. This is not only good practice in order to avoid chlorine tastes but also that better bacteriological results may be obtained. When samples are taken immediately after chlorination and again at the outlet of the storage reservoir, definite information on the value of this reaction period is obtained.

It is desirable to secure data on the condition of the water as it reaches the consumer. We have found a marked difference in gas formation when lactose broth is inoculated immediately after the sample is taken as compared with inoculations from the same sample made several hours afterward, less gas being produced in the latter case. For this reason it is advisable to let the sample stand, at room temperature, before making the analysis, during such a period as is required for the water to reach the nearest consumer.

Results of Using Sodium Aluminate With Alum in Filtration Work

By Sheppard T. Powell
Consulting Chemist, Baltimore, Md.

DURING the past year considerable interest has been manifest in the use of liquid sodium aluminate applied in conjunction with alum in municipal filtration work. A number of these tests have indicated that the alum-aluminate process has marked advantage over straight alum treatment with many waters. The results obtained by this treatment with soft highly-colored water have been excellent. The process produces better color reduction with lower doses of chemicals than when alum only or alum and lime is used and the treated water contains less free CO_2 and less residual alumina.

The following table indicates the results obtained from the treatment of a highly-colored soft water:

Chemical applied	Alum	Alum + 0.25 of a grain of sodium aluminate
Grains per gallon	3.2	1.6
CO_2	16.0	5.0
pH	6.0	7.1
Residual	0.4	0.0

From the above data, it will be noted that it required 3.2 grains per gallon of alum to obtain good clarification when alum only was used, whereas equally good clarification was obtained by 1.6 grains of alum and 0.25 of a grain of liquid sodium aluminate. These figures are of particular interest since it was shown that the filtered water was free from residual alumina and the hydrogen-ion concentration was 7.1 (alkaline) as against 6 (acid). The free CO_2 was 11 p.p.m. less in

the aluminate-alum treated water than in the straight alum process and there was a reduction in the alum dose of 50 per cent.

The net saving in the total cost of chemical treatment amounted to more than $1.25 per million gallons of water treated. The saving will, of course, vary with the size of the plant and other local conditions.

Protective Linings for Cast-Iron Pipes

By Charles W. Sherman
Metcalf & Eddy, Consulting Engineers, Boston, Mass.

IT IS well-known that in many places loss of carrying capacity as a result of tuberculation in cast-iron pipes is a serious matter. The diagram on p. 303 of the *Manual of Water Works Practice*, A.W.W.A., gives a table showing the reduction in coefficient of various sizes of pipes which should be expected on the basis of average experience. This shows a loss of carrying capacity of about 40 per cent in 30 years for 6-in. pipe, in 37 years for 12-in. pipe, and in 42 years for 24-in. pipe. In many places, particularly where the waters are soft, tuberculation takes place much more rapidly than indicated by these figures, and losses of carrying capacity of as much as 60 or 70 per cent in 20 to 25 years in the case of 6-in. and 8-in. pipes are not unknown.

Burt B. Hodgman in the *Journal* of the A.W.W.A., 1918, p. 152, quotes data of actual tests in 29 cases, most of them showing serious loss of carrying capacity. Four cases showing reduction of capacity ranging from 75 to 80 per cent in periods of 18 to 20 years are given, in addition to one other showing 80 per cent loss in 20 years where the water was high in sulphur.

In view of these conditions, the water-works engineer may well give serious consideration to the matter of obtaining better protection of the interior surface of pipes unless he has positive information that the water is not of such a character as to cause tuberculation.

With the exception of the old-fashioned cement-lined pipes made with thin sheet-iron shell, which were adopted primarily on account of lesser cost and not on account of their freedom from tuberculation, attempts to maintain carrying capacity have until recently been principally in the nature of obtaining a more satisfactory tar or asphalt coating. As a rule, these attempts have not met with much success. About five years ago, J. E. Gibson of Charleston, S. C., bearing in mind the experience with cement-lined pipes as to maintaining carrying capacity, conceived the idea of applying a thin cement lining to ordinary cast-iron water pipes. The first linings were similar to those used in the old cement-lined pipes, being composed of natural cement spread upon the surface of the pipe by means of a cone drawn through the pipe. After a short time, however, this process was abandoned in favor of a lining of portland cement and sand, distributed over the pipe by centrifugal force while the pipe is rotated at high speed. Such linings have been used for about four years and considerable experience in their application and in handling and laying pipes containing them has now been accumulated. In general, they have been found satisfactory.

Only time can tell whether the object desired will be attained by this method. It is possible that the very thin linings used in this country will not provide permanent protection to the iron. It may be noted that in England cement-lining approximating ⅛ in. in thickness is applied to cast-iron pipe. There can be little doubt that these linings, whatever their thickness, will be efficacious in preventing tuberculation while they last, but there may be some question about their permanency. Experience thus far indicates that they are likely to be effective for many years, if not permanently.

Another attempt to provide adequate protective coating, applicable to both cast-iron and steel pipes, is represented by the Talbot coating and other similar coatings which have been used by British engineers for two or three years. The Talbot coating is described in the *Journal* of the New England Water Works Association, December, 1926. It consists of a mixture of asphalt and ground rock, applied hot to the interior surface of the pipe by centrifugal force. The lining is generally about ¼ in. in thickness. This provides, at least when new, an extremely smooth surface and the coating adheres to the pipe with great tenacity. It seems to offer much promise of proving efficacious in reducing or eliminating troubles due to tuberculation.

Still another type of protective coating is suggested in a note which appeared in *Water and Water Engineering* (London), March 21, 1927. This refers to a coating of chemically treated glass which, it is stated, can be applied in practically any thickness. It is also said that an exceedingly fine polish can be given to the surface, thus reducing frictional losses to a minimum. No information as to the method of application is given. As to its durability, the only statement given is that steel plates coated in this way have been immersed in sea water for over 10 years, after which no trace of corrosive action was discovered. If this coating can be applied on a scale which is commercially practicable, and if it is found permanently to protect the surface of the metal and not be injured by cutting, tapping or joining, it should prove of great value for the lining of water pipes.

Providing Additions and Extensions to Existing Water Pumping Station

By William L. Havens
Associate, George B. Gascoigne, Consulting Sanitary Engineer, Cleveland, Ohio

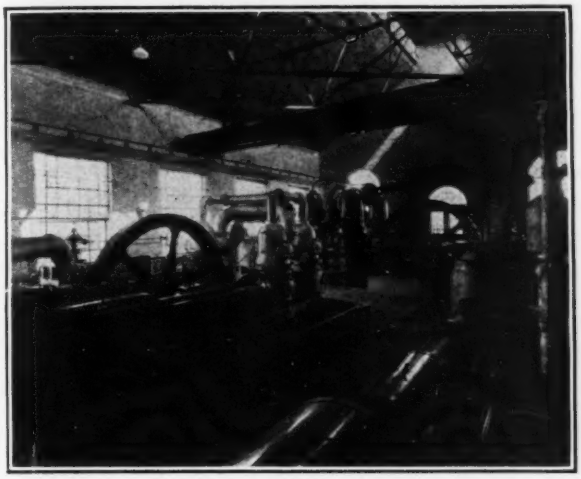
DURING the past year the city of Alliance, Ohio, has completed extensive additions to a pumping station which was built 25 years ago and remodeled in 1917, and which has for some time been deficient in capacity and lacking in many respects the practical arrangement and efficiency of a modern water-works plant. In the absence of standby units it has been necessary to install the new improvements in such a way that all existing equipment might be kept in operation. This was particularly imperative since no storage is provided, the pumps discharging directly into the distribution mains.

Before the recent additions were installed, the steam for the entire plant was obtained from two horizontal water-tube boilers having a capacity of 250 hp. each and two vertical water-tube boilers having a capacity of 250 hp. each. The horizontal water-tube boilers were practically useless since the tube sheet in one was cracked and the baffles in the other had fallen down.

New Methods in the

Water-Works Field

Consequently, the entire load was carried by the two vertical water-tube boilers which were giving satisfactory service in spite of their 17 years of operation. Both boilers, however, were necessary in order to carry the plant load. The high service pumping equipment consisted of one 6-m.g.d., cross-compound, crank-and-flywheel pump 7 years old, one 5-m.g.d., triple, direct-acting, duplex pump 15 years old, and one 4-m.g.d., triple, direct-acting, duplex pump 25 years old. The last-named pump was considerably worn, as might be expected at its age, and could not be made service-



INTERIOR OF REVAMPED PUMPING STATION IN ALLIANCE

able without unwarranted expense. This condition left the station without a high service standby unit, since both the 6-m.g.d. and 5-m.g.d. pumps were required continuously to maintain the pressure, the former pump carrying about two-thirds of the total load.

The new equipment has been installed under several contracts and includes two 350-hp. water-tube boilers with the necessary foundations, building, piping and chimney construction, and one 10-m.g.d. high-service pumping unit with the necessary foundations and piping connections. The new boilers are equipped with mechanical stokers and are of such capacity that one unit will operate the entire plant, permitting thereby the use of the other unit for standby service. The old boilers may be used in case of shutdowns or exceptional pumping demands. The boiler room addition was designed to conform in appearance to the architecture of the existing building.

The improvements have been installed in such a manner that the existing equipment took care of all consumption requirements at all times during the period of construction. The cost of the improvements amounted roughly to $150,000 and their installation has resulted in a yearly operating saving in labor and coal of about $7,000.

The installation of these improvements really emphasizes that considerable revamping of a water-works pumping station can be done without interruption to service. Today the city of Alliance has a modern pumping station that will amply provide for its needs well into the future, the possible exception being the installation of low-lift pumps, as is contemplated within a short time.

J. O. Stanley is superintendent of water, under whose immediate direction these improvements were installed, while Franzo D. Miller is director of public service.

Water-Driven Booster Pumps in Use at Louisville, Ky.

By Charles B. Burdick
Alvord, Burdick & Howson, Engineers, Chicago

THE FACT is sometimes overlooked that a pumping station containing high-duty pumping engines may use the power developed in the water pumped for miscellaneous purposes in the station with better economy than is possible by using power developed directly from steam. This is particularly true where the high-lift pumps are relatively large and the miscellaneous power uses are relatively small. The use of water power has a double advantage in that steam consumption of the high-lift pumps is relatively small per unit of water delivered and small equipment uses steam at a high rate per unit of output.

These conditions have been utilized to advantage by the Louisville Water Co., in connection with a booster pump installation for supplying the Lakewood district, served from the main pumping station at Crescent Hill.

Up to the present this high-service district, now consuming about 2 m.g.d., has been served by a direct-acting compound condensing pump of about 3 m.g.d. capacity, lifting the water out of the clear well and discharging it into the distribution system at about 195 ft. total head. The steam duty developed by this pump when new probably did not exceed 45,000,000 ft.-lb.

The Crescent Hill station also serves the city of Louisville consuming an average of 42 m.g.d. and contains 115 m.g.d. capacity in vertical triple pumps and a 40-m.g.d. turbo-centrifugal pump now being erected, pumping against a city pressure of about 50 lb., or 115 ft.

There is an elevated steel tank adjoining the pumping station having a capacity of 1 m.g. of such elevation that the ordinary pressure of the Lakewood pump would fill the tank approximately half full. The equipment now being installed is designed to take the water at the pressure generated by the main pumping engines and boost it approximately 106 ft. into the elevated tank, to which the Lakewood supply line will be connected. This will improve the pressure condition in the Lakewood district and provide storage in the elevated tank for the hourly peaks of consumption. It will also overcome half the Lakewood lift with the large station pumps and accomplish the remaining half of the lift with very good economy by use of a water motor-driven centrifugal pump. No water will be lost by this latter unit as the discharge from the water motor will be returned to the clear well.

This installation consists of a 10-in. centrifugal pump direct-connected to a 12-in. 125-hp. motor delivering 3,000 g.p.m., taking water at 115-ft. head and boosting it 116 ft. The water motor receives water from the city mains under a head of 115 ft. The overall efficiency of the motor and pump is 64 per cent at 3,000 g.p.m. and 64.6 per cent at 2,100 g.p.m. and 139 ft. net head, which would prevail at night when the pressure at the main station is usually reduced to 40 lb.

For reserve service, a similar pump is being installed driven by an electric motor taking current from either of two generators, commonly used for lighting and general service in the plant. Although these generators are first class machines of good efficiency, operating condensing, the water motor driven unit is considerably more efficient, and ordinarily will be used.

As previously stated the duty of the present Lakewood direct-acting pump is not more than 45,000,000 ft.-lb. With the water motor driven pump in service, about half of the lift will be accomplished at 190,000,000 ft.-lb. duty, and the remaining half at about 123,000,000 ft.-lb., making an average duty of approximately 156,000,000 ft.-lb. This indicates a steam consumption less than 30 per cent of the steam now used by the direct acting pump furnishing this service.

Mixing Basin at Atlanta Water-Works

By H. F. Wiedeman
Wiedeman & Singleton, Inc., (Successors to Paul H. Norcross)
Atlanta, Ga.

After a thorough analysis of mechanical and gravity mixing plants, the latter type was selected for the purification plant of the Atlanta water-works, replacing a method of feeding alum and lime directly to the supply line to the coagulation basins.

When the plant was originally constructed, solution feed apparatus was installed in the chemical house at the head of two coagulating basins and the chemical was added to the water through a short length of pipe without any mixing, with more or less satisfactory results. As the plant grew, more coagulating basins were constructed until in 1923, five basins were being operated and the chemical was being run through approximately 450 ft. of 2-in. pipe to a 60-in. main, which brought the water from the reservoirs to the coagulating basins. The chemical lines were in duplicate and practically constant maintenance work was necessary to keep them in service. The coagulating basins were then operated in series and fairly effective coagulation was obtained.

With the growth of water consumption, and the construction of a new filtration plant, however, the loss of head, due to the operation of the basins in series, not only interfered with the operation of the new plant, but became so great that it was necessary to operate the basins in parallel to reduce the velocity and obtain satisfactory sedimentation. As soon as the basins were operated in parallel, difficulty in obtaining uniform coagulation was experienced. The chemical entered the 60-in. main about 50 ft. from the point where the water was distributed to the five basins and as a result, coagulation was not uniform in all the basins.

A temporary chemical dosing plant was then constructed at the raw water reservoir outlet about 500 ft. from the coagulating basins, and the 60-in. main and intake were used for mixing. This improved conditions somewhat, but coagulation was still difficult at times, resulting occasionally in a slightly turbid effluent from the filter plant.

Plans for a mixing basin and chemical house were then in progress, but due to delays in the acquisition of the necessary property, construction was not started until May, 1926, and completion was in December of the same year. The gravity type mixing basin was determined upon after thorough analysis had been made of

New Methods in the

mechanical and gravity plants, because of simplicity of operation. It was necessary to limit loss of head to a minimum, because the raw water reservoir from which supply is taken is at the same elevation as the coagulation basins, and because of physical conditions could not economically be raised more than 2 ft. Extreme turbulence was avoided and the basin was designed on the theory that best results could be obtained by gentle agitation combined with a time element sufficient to permit the reaction to be completed. The basin, which is now operating at a 30-m.g.d. rate, is causing a loss of head of 5 in.

It is designed for an ultimate capacity of 60 m.g.d. and is 78x136 ft. in plan, of the "around the end" type, with 13 passes, giving a total travel of 1,664 ft. with 12 turns. It is divided into three sections which enables the operator, by manipulating sluice gates connected with the outlet flume, to vary the period of mixing. At the present rate of consumption, which is 30 m.g.d., the retention period is 40 min. for the entire basin, with an average velocity of approximately 0.5 ft. per sec. Baffles are of wood, supported by concrete posts, 12x14 in. in cross-section on 8-ft. centers. These posts are tied across at the top of the basin with light concrete beams. The water enters the north end of the basin, through a concrete flume. The entrance is through a 60x60-in. sluice gate set at an angle with the first pass of the basin, causing the entering water to impinge upon the baffles, which creates a turbulent condition at the point where the alum is added. The raw water pH varies between 7 and 7.2, and this is lowered to 6.4 or 6.6 in obtaining coagulation. In the outlet pass of the basin, lime is introduced in sufficient quantity to raise the pH of the coagulated water to 7.2, which provides an alkalinity of approximately 14 p.p.m.

The chemical house is built on the north wall of the entrance flume of the mixing basin, and contains four dry feed machines, two of which are used for alum and two for lime, but they are interchangeable. Chemicals are stored on the second floor of the building and discharged into hoppers, which extend from the lower floor to the second floor. The dry feed machines are driven by water motors, the discharge from which is used to carry the chemicals. They discharge into open concrete troughs, running the full width of the building and having three openings to the mixing basin. There are two of these troughs, one for lime and the other for alum, and either alum or lime may be dosed at the inlet of the basin, at the middle point, or on the last pass in the outlet. The elimination of lime dosing at the inlet before the alum is applied was thought necessary at times before the operation of this new mixing basin. With the close control of chemical doses and the thorough mixing which is now possible, a saving of approximately 25 per cent of the chemical used has resulted during the first four months of operation. The operating force which was necessary with solution feed equipment was also reduced. The floc begins to form in the mixing basin before the water has traveled one-fourth the distance through the basin, and when it leaves the basin, it is fully formed. It settles out quickly when it reaches the coagulating basins, making the basins more

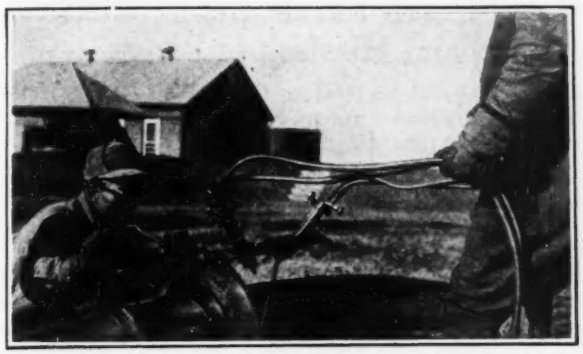
Water-Works Field

effective since no part of these basins is used in completing the reaction.

W. Zode Smith is general manager of the Atlanta water-works. The plant was designed by the writer's office. Lowell Cady of the same office acted as engineer supervising the construction.

Efficient Cutting Outfit for Salvaging Pipe Lines

PRACTICALLY no oil pipe line is permanent. It is constantly necessary to move many lines and the growing development toward welded joints has often made this a difficult and costly procedure. The Prairie



DEVICE FOR CUTTING WELDED PIPE LINES

Pipe Line Co. has welded all of its lines that have been laid in the past four or five years. In order that a maximum salvage may be obtained when it is necessary to cut these welded pipe lines, N. E. Wagner, superintendent of welding, has designed and patented the device shown in the accompanying illustration.

As will be noticed, two oxyacetylene torches are mounted at 45-deg. angles so that the resulting ends of the pipe lengths will be properly beveled for future welding. These torches are slowly revolved about the pipe by a small crank and gear wheels as shown. The equipment is especially efficient and rapid, and the only waste that occurs is the strip of metal between the cutting flames.

Continuous Inspection Minimizes Water Waste at Madison, Wis.

By L. A. Smith
Superintendent of Waterworks, Madison, Wis.

CONTINUOUS inspection of the water distribution system, as well as the meters, by meter readers has reduced the amount of water unaccounted for in Madison, Wis., from 23.2 per cent in 1918 to 6.7 per cent in 1925.

Every six weeks when meters are read, the inspectors listen carefully for any leaks in the service. If a leak is heard the water is shut off at the meter to determine its location. When the leaks are inside the building, the owner is formally notified that water is being wasted, but when the leaks are outside of the building ahead of the meter, the service department is notified and the leak is located and repaired by the department. The meter inspectors also check fire hydrants on each round and watch for any leaks in the distribution system. Any leak reported is promptly located and repaired by the department. It has been found that meter inspectors can carry on this additional work without decreasing the reading efficiency.

Some saving in consumption has also been effected by judicious use of water by the various city departments, street sprinkling being diminished materially as more streets are paved.

Air Binding of Filters Attributed to Diatoms

By L. C. Billings
Superintendent of Filter Plant, Grand Rapids, Mich.

THE formation of an impervious mat of microscopic plant organisms over the sand bed surface in the filters at the Grand Rapids filter plant is an explanation given for the air bound condition found when filters are taken out of service for washing.

The effects of diatom growth were not noticed until in 1924 when open settling basins were put into service. The combination of sunlight and the presence of bicarbonate in the water due to only a part of the bicarbonates being removed by the lime treatment, were conducive to the growth of certain types of diatoms.

Examination of settled water from the open settling basins showed large numbers of nitzchia and melosira, the latter predominating. These microscopic organisms are transparent and threadlike in form, undiscernible to the naked eye, but having a greenish hue in large masses.

When washing the filters, quantities of air would be released from the sand beds by the wash water. No explanation for the source of the air was available. Filter runs were being shortened during the summer of 1926 and this condition came to a climax in August, when filter runs were reduced to two and four hours. The only way a filter could be operated at all was by "bumping," which was not conducive to efficiency in operation.

The explanation finally made for this air-bound filter condition was that a mat of microscopic organisms would form on the surface of the sand bed and finally become impervious, no longer permitting the water to penetrate the sand. A negative head would then be produced in the filter bed causing air to accumulate in the lower sand and gravel strata and in the underdrains. When the filter was "bumped," the accumulated air would be released.

In attempting to remedy this condition, 1 to 2 in. of the top layer of the sand was removed by scraping. The filters were again placed in use and the same trouble was found to exist after operating for a short period of time. It was then decided to treat the water with an excess amount of lime so as to produce about 5 p.p.m. of causticity in the filtered water. This treatment was carried on for 48 hr. after which the normal treatment of lime was resumed. Immediately after the excess amount of lime was added to the water, the filters began to operate for longer periods between washings. The periods continued to lengthen until they were again normal. This 48-hr. treatment was found sufficient to eliminate the trouble for the remainder of the season, as weather conditions changed thereafter and checked the growth of the organisms.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Montreal Typhoid Epidemic Nearing 3,000 Cases

Provincial Health Officer Orders City Authorities to Stop Two Milk Supplies

Recrudescence of the Montreal typhoid epidemic in its tenth week after four weeks of erratic daily decline was followed by an order, May 11, of the executive committee of the city council to stop giving out daily reports of new cases. From March 3 to May 3, inclusive, there were 2,628 cases; May 4, 16. For May 5 and 6, figures are not available. For the four days ending May 10, the cases totaled 93, or an average of 23 a day. After that, daily reports ceased, but with some 2,750 cases reported up to May 11, and 40 in a single day of the recrudescence, and with a rapid increase in cases sent to the hospitals, the epidemic bids fair to run beyond 3,000 cases. The figures do not include cases in the suburbs.

The cause of the protracted course of the epidemic did not come out until May 18, when Dr. Alphonse Lessard, director Provincial Bureau of Health, ordered the city authorities to prevent the further sale of milk by the Montreal Dairy Co., Ltd., and the National Dairy, Ltd., to which he declared that at least a majority of the cases were due, and each of which was delivering milk without a permit. The city authorities having taken no action under the order, the Provincial Bureau of Health, at 5 p.m., May 21, closed the establishments of the National Dairy Co. and turned over those of the other company to the absolute control of M. H. McCrady, chemist of the Provincial Bureau of Health.

PUBLICATION OF FACTS URGED

On May 19, the Montreal Convention & Tourist Bureau gave a luncheon to representatives of the Chamber of Commerce, the Board of Trade, the railways, hotels, department, and other stores, and manufacturing establishments. A plea was made by this body for the collection and public announcement of the facts so that the city would not be injured by "distorted and exaggerated rumors."

On May 20, the Medico-Chirurgical Society of Montreal adopted resolutions declaring, among other things, the belief that the outbreak "was due to the failure of the civic authorities to enforce the civic health by-law concerning milk"; that "the citizens of Montreal do not receive the same consideration for the protection of health as do those of other cities of a similar size"; and that the health department budget should be "made adequate for this purpose."

On May 19, the Montreal *Star* severely criticized the city authorities for their laxness in dealing with the epidemic and for their delay in acting on the order of the provincial health director. It characterized as "stupid and clumsy" the attempt of the executive committee to suppress the facts.

In the United States, both the Department of Agriculture and the New York Health Department barred from the United States milk produced near enough to Montreal to be under suspicion, the federal embargo covering a radius of 200 miles. The U. S. Public Health Service, before the recrudescence of the epidemic, sent warnings to American state and local health authorities to look our for typhoid carriers from Montreal, especially those seeking employment as food or milk handlers. The American contingent of the conference of state and provincial health authorities in session at Washington on May 20, adopted resolutions recommending inoculation against typhoid for tourists finding Montreal a necessary stop on their itinerary.

From the start, the epidemic has

(*Continued on p. 879*)

Levee Failure at McCrea Floods Region Between Atchafalaya and Mississippi Rivers

Weak Point in Eastern Atchafalaya System Gives Way—Large Part of Mississippi Flood Appears to Be Going Down Atchafalaya Valley

THE Atchafalaya River valley continues to hold the interest in the Mississippi flood situation. Last week it was hoped that the eastern side of the basin, lying between the east-bank levees of the Atchafalaya and the west-bank levees of the Mississippi, could be saved from flooding except possibly by backwater in the lower portion, but early Tuesday morning the east-bank levee near the village of McCrea gave way and water is now flooding Point Coupée Parish and will overflow part of the Iberville Parish before it returns to the Atchafalaya or reaches the Grand River.

No measurements have been announced of the flow of water down through the Atchafalaya basin but from the fact that the gage at Baton Rouge began to fall after the Bayou des Glaises levee failed and before the crest of the flood reached that point seems to indicate that a great part of the flood is going down the Atchafalaya valley rather than the Mississippi. The flood capacity of the Atchafalaya at the Simmesport sill alone is about 400,000 sec.-ft. and apparently an equal or greater amount is passing through the Bayou des Glaises crevasses.

Major W. H. Holcombe, Corps of Engineers, district engineer at New Orleans, sends the following report under date of May 24:

"Additional developments in levee situation on lower river since May 17. Crevasse occurred 3 a.m. today at McCrea on the east bank of the Atchafalaya River. McCrea is about 12 miles above the town of Melville where earlier break occurred but on opposite bank of river. This crevasse occurred after a 7-day fight in which 2,500 men were engaged. It was caused by a caving bank. Waters from this break will flood greater portion of land from Old River south except area between Bayou La Fourche and Mississippi River. The more important towns are on high ground near the west bank of the Mississippi River and should not be affected. All levees on west bank of Mississippi River from Old River south, and those on east bank from Baton Rouge south, continue to hold and are in good condition. Barring unexpected developments there should be

Engineering Fifty Years Ago

From *Engineering News*, May 26, 1877

THE numerous accidents of late, both to public and to private buildings, naturally calls forth inquiry as to the cause of such disasters and the means of avoiding them in the future.

That they are unnecessary, no one for a moment doubts, but why are they so much more numerous than formerly? is a question of considerable interest at present, and which I think can be readily answered.

The accidents have happened to two classes of buildings—the one, large public edifices erected at great cost; the other, business warehouses. These two classes of accidents are due to very different causes and must be considered separately. Our new public buildings are upon a much larger scale and are far more pretentious and costly than formerly and in consequence require more skill on the part of the designer and superintendent. The day has past when a successful architect can grow up from an office-boy; he must now have a preliminary scientific training, and be exact in his calculations.

GAGE HEIGHTS AT LOWER MISSISSIPPI VALLEY POINTS

	Mississippi River						Red River	
	St. Louis	Memphis	Vicksburg	Natchez	Baton Rouge	New Orleans	Shreve-port	Alex-andria
Flood stage*...	30.0	35.0	45.0	46.0	....	17.0	29.0	....
Provisional Levee grade**	....	51.5	58.0	57.5	48.1	25.2	....	....
1922	34.0	42.5	54.8	55.3	45.7	21.3	....	....
Previous high..	41.4	46.5	53.8	53.5	43.8	21.1	....	....
1927								
April 24	35.6	45.9	54.8	55.3	44.8	20.8	**34.1**	
April 25	35.8	**45.9**	54.5	55.2	45.0	21.0	35.1	38.0
April 26	**36.1**	45.6	54.4	55.0	45.0	20.9	36.0	38.3
April 27	35.6	45.4	54.9	55.0	45.0	20.8	36.7	38.7
April 28	34.6	45.1	55.7	55.1	45.0	20.8	37.2	39.0
April 29	33.4	44.7	56.3	55.5	45.1	20.8	37.4	39.5
April 30	....	44.3	57.2	56.1	45.4	20.8	**37.4**	40.0
May 1	....	43.8	57.9	56.5	45.8	20.7	36.9	40.5
May 2	....	43.2	58.2	56.4	45.7	20.7	36.4	40.1
May 3	....	42.7	58.5	56.4	45.4	20.4	35.4	41.3
May 4	26.8	42.2	**58.7**	**56.5**	45.6	20.4	34.3	41.5
May 5	25.4	41.6	58.2	56.4	45.7	20.4	32.6	41.9
May 6	24.1	40.8	58.0	56.1	45.8	20.4	31.9	42.1
May 7	23.7	40.6	**57.7**	55.7	46.0	20.3	29.2	42.3
May 8	25.4	39.8	57.2	....	46.1	20.3	27.6	42.4
May 9	27.3	39.2	57.0	55.3	46.1	20.3	26.1	42.2
May 10	29.5	38.4	56.6	55.1	46.3	20.2	24.6	41.9
May 11	30.3	37.6	56.4	55.1	46.5	20.3	23.0	41.5
May 12	29.1	36.9	56.0	55.0	46.8	20.2	22.6	40.9
May 13	27.6	36.4	55.7	55.1	47.1	20.4	22.6	40.3
May 14	26.3	36.0	55.4	55.1	47.4	20.6	23.2	39.4
May 15	25.2	35.8	55.2	55.1	47.8	20.7	22.8	38.5
May 16	25.9	35.7	54.8	54.9	47.7	20.6	21.9	37.7
May 17	27.0	35.6	54.4	54.7	47.6	20.6	20.6	36.9
May 18	27.3	35.4	54.0	54.5	47.5	20.5	19.2	35.9
May 19	27.2	35.1	53.6	54.3	47.4	20.4	17.7	34.8
May 20	29.6	34.6	53.2	54.0	47.3	20.4	16.6	33.4
May 21	26.7	34.0	52.8	53.8	47.2	20.3	15.6	31.8
May 22	26.4	33.3	52.5	53.6	47.1	20.2	15.5	30.1
May 23	25.6	32.5	52.2	53.3	47.1	20.3	15.6	30.8
May 24	24.9	31.8	51.9	53.1	46.8	20.0	16.0	....

* Approximately a bank-full condition above which levees are required.

** Grade established by the Mississippi River Commission as the desired height for the levees.

no trouble with these levees in spite of stages still a foot higher than those recorded during the flood of 1922. River is falling gradually."

Roger B. McWhorter, special engineer of the Orleans Levee District, reports that the crevasse cut through the levee at Caernarvon is widening at the rate of 20 ft. per day and that it may be necessary to tie the levee at the lower end.

Conditions on the upper river are improving rapidly. Major D. H. Connolly, Corps of Engineers, district engineer at Memphis, sends the following dispatch:

"Since my wire of May third the Mississippi flood has dropped below the flood stage at all points in first and second Mississippi River districts extending from Cape Girardeau, Mo., to mouth of the White River, a distance of 450 miles. All levee crevasses still flowing to such an extent that even partial closure against so-called June rises is impracticable.

"The president of the Mississippi River Commission, by authority of the Chief of Engineers, has authorized any temporary or preliminary work in these crevasses that may be necessary to prevent the overflowed areas once unwatered being again flooded during present cropping season and this office stands ready to carry such authority into effect when opportunity develops."

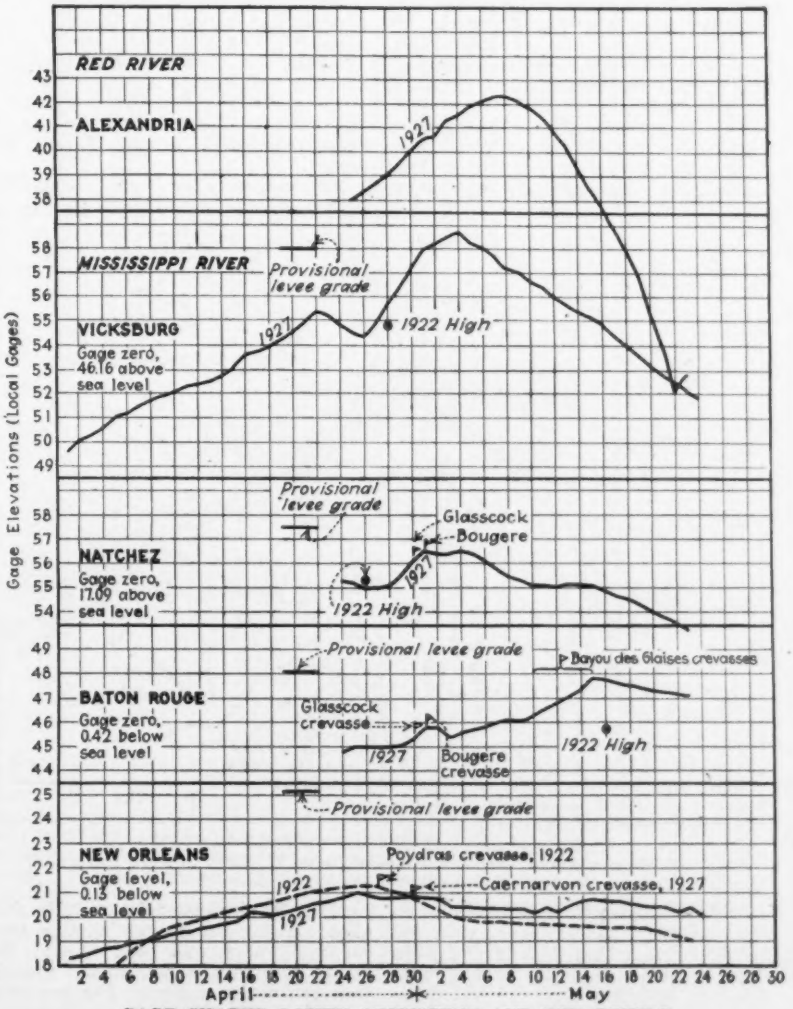
Development of Water Power on Potomac River Proposed

Development of the water-power resources of the Potomac River and its tributaries is proposed by the Potomac River Corporation in an application for a preliminary permit filed with the Federal Power Commission.

The company proposes building a dam 115 ft. high at Chain Bridge near Washington, a dam 100 ft. high 10 miles farther upstream at Great Falls, Md., a dam 50 ft. high at Harpers Ferry, a dam 130 ft. high on the Shenandoah River near Charles Town, W. Va., a dam 213 ft. high at Brocks Gap, Va., in the north fork of the Shenandoah, a dam 226 ft. high near the mouth of Great Cacapon Creek, and a dam 140 ft. high on the south fork of the Potomac River near Romney, W. Va. The dams at Brocks Gap, Charles Town, Great Cacapon and Romney will form storage reservoirs of capacities of 406,000, 260,000, 263,000, and 465,000 acre-ft., respectively.

The plan is similar to that proposed in a report made for the Federal Power Commission by Lt. Col. M. C. Tyler in 1921, except that in the present project the dams at Harpers Ferry and Charles Town are added. This will make it possible to increase the installed capacity from 180,000 kw. to 225,000 kw. The cost of the Tyler plan was estimated at $44,000,000; that of the Potomac corporation $57,000,000.

It is expected that if the project is built power will be supplied to points in Maryland and West Virginia as well as to Washington.



GAGE CHARTS, LOWER MISSISSIPPI AND RED RIVERS

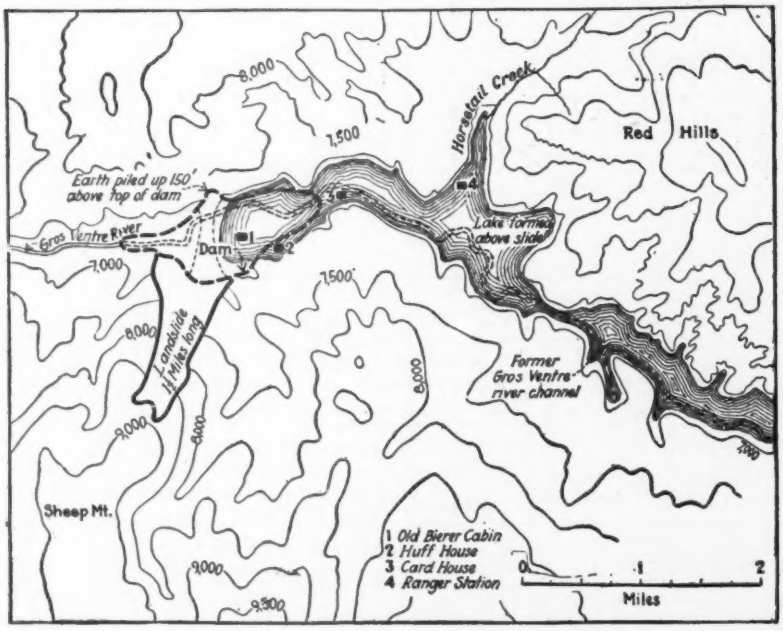
The time when the major crevasses in the lower river occurred is indicated upon the charts which they affect, also the days upon which the 1922 flood peaks occurred and the elevations are given. The relation of the local gages on the Mississippi to Gulf level is shown.

Gros Ventre, Landslide Dam in Wyoming, Breaks

Heavy Rains Cause "Failure"—Waters Released Practically Wipe Out Village—Seven Drowned

The dam formed by a landslide which blocked the channel of the Gros Ventre River in Wyoming two years ago gave way suddenly on May 18, releasing the impounded waters in a destructive flood. A wire to *Engineering News-Record* from Frank C. Emerson, governor and former state engineer of Wyoming, reports that the little town of Kelly, 3½ miles below the dam, was practically swept away with the loss of seven lives, and although inhabitants farther down the valley received warning in time to escape, there was extensive property damage for 30 miles below particularly to bridges and highways. Gov. Emerson had not yet received details as to the nature of the failure of the "dam" and the amount of impounded water released. Wilson, 25 miles below the dam, is reported to have been reached by a 20-ft. flood 2 hr. after Kelly was struck. The flood subsided quickly and water level was back to normal on the day following. A description of the dam, written by Mr. Emerson, when state engineer, appeared in *Engineering News-Record*, Sept. 17, 1925, p. 467.

The Gros Ventre River is an important tributary of the Snake River which it joins about 40 miles south of Yellowstone Park. The earth slide, presumably started by earthquake, occurred on June 23, 1925, and formed a dam 180 ft. high with a base thickness of more than 1½ miles along the stream bed. A month after the slide the water impounded was estimated to total 65,000 acre-ft. and at that time practically the entire flow of the river was passing through the dam near the center and about 30 ft. below the top. Because of the quantity, nature and placement of the materials that formed the dam it was believed that the lake would be permanent and that the river would work out for itself a rapids leading down to the old stream bed. The sudden release of the impounded water, therefore, came as a great surprise and caught the valley below unawares.



LOCATION OF DAM IN GROS VENTRE CANYON
Map published in *Engineering News-Record*, Sept. 17, 1925, to show location of landslide which dammed the Gros Ventre River.

Carquinez Strait Bridge Opened to Traffic May 21

Elaborate ceremonies, widely advertised, brought a crowd estimated at 47,000 automobiles and 50,000 people to the opening of the toll bridge across Carquinez Strait near San Francisco on May 21. Dedication ceremonies were held in the early afternoon at the north end of the structure where automobile caravans from north and south met for the occasion. Of several articles devoted to features of this structure that have been published in *Engineering News-Record* the latest appeared in the issue of May 12, 1927, p. 777.

No bridge tolls were charged on the opening day but on May 22 the tolls on about 9,000 cars totalled almost $8,000. The tolls that then went into effect are 60c. for automobiles and 10c. for each passenger. The pedestrian commutation rate is $2 per month and for an automobile with driver, $17.50 per month.

Application for an injunction brought by navigation interests to prevent opening the bridge until a permanent fender was built around the center pier was denied on the ground that the bridge company has complied with War Department requirements for a temporary fender, pending settlement of the controversy of long standing as to fender design satisfactory to all concerned.

K. C. Southern Railway Plans Disapproved

Interstate Commerce Commission Rejects Proposal to Form 5,800-Mile System

The proposal of the Kansas City Southern Ry. Co. to form a 5,800-mile railway system in the southwestern part of the United States by grouping under its control the St. Louis Southwestern Ry. and the Missouri-Kansas-Texas R.R. Co., has been disapproved by the Interstate Commerce Commission on the ground that no definite provision had been made in the proposal for caring for the rights of the minority stockholders and also because the plan placed the control of two large railroad companies in the hands of a small company with too little direct financial interest in the controlled companies.

In the proposal disapproved by the commission the Kansas City Southern asked authority to acquire control of the Missouri-Kansas-Texas R.R. Co., by purchase of capital stock and at the same time the latter railroad applied for authority to acquire control of the St. Louis Southwestern Ry. Co. (Cotton Belt) by similar purchase of capital stock, thus concentrating the control of the 3,189-mile M-K-T Ry. system and the 1,747-mile Cotton Belt system in the hands of the 865-mile Kansas City Southern. In objecting to this arrangement the commission pointed out that "about $25,500,000 of its (the Kansas City Southern's) common stock would effectively control the company and the market value of this amount of stock on Nov. 13, 1926, was less than $11,000,000 or less than 11 per cent of the market value of all the stock of the three companies, about 7.2 per cent of the total value of the stock if the M-K-T adjustment bonds should be converted, and less than 2 per cent of the aggregate amount of their assets." This, said the Commission, "seems too small a base upon which to build such a financial pyramid.

While the proposed grouping of these three railroads was not made in the commission's tentative consolidation plan, nor in Professor Ripley's grouping, the commission does not find the grouping, in itself, objectionable. There is not much competition between them and they so supplement each other that the loss of competition may be more than offset.

In its decision the commission raises the question whether the Kansas City Southern in acquiring sufficient stock of the M-K-T and of the Cotton Belt to dominate their action without authority from the Interstate Commerce Commission did not violate the Clayton antitrust act and the Sherman act. It is of the opinion that it did unless the transportation act by implication allows such acquisition in advance of granting of authority to do so. The applicants claim that it is necessary to acquire such control before making its plan public in order to keep from having to purchase stock at inflated prices, but the commission states that it doubts that such preliminary ascendancy was necessary or conducive to the fixing of equitable terms of union.

Agricultural Engineers to Meet at St. Paul

The 21st annual meeting of the American Society of Agricultural Engineers which will be held June 22 to 25 at the University Farm, University of Minnesota, St. Paul. The program will include technical addresses and committee reports, group meetings and conferences. Rural electrification and reclamation will receive consideration during the entire first day. Papers on electric refrigeration, automatic feed grinding and the advancing use of electricity in agriculture will be presented in the rural electrification division. Drainage and irrigation, erosion, forestry, land clearing, land development, runoff and soil hydraulics will be subjects for committee reports in the reclamation division. Entertainment features include a picnic supper and the annual banquet.

Detailed information relative to the meeting can be secured from either William Boss, University Farm, St. Paul, or Raymond Olney, St. Joseph, Mich., who is secretary of the society.

Fulton St. Tunnel Bid $22,246,000

Bids received on May 18 for construction of the Fulton St. tunnel of the new subway rapid-transit system in New York City, described in *Engineering News-Record*, Feb. 24, p. 328, ranged from $22,246,000 to $30,203,000. Mason & Hanger were low bidders, with Underpinning & Foundation Co. next at $25,212,000. The other bidders, in order, were Patrick McGovern, Rodgers & Hagerty, Rosoff Construction Co., George H. Flinn, and Arthur A. Johnson.

Mason & Hanger were also low bidders in the alternative bidding for the work in two sections, easterly and westerly, with $13,600,000 for the west section (from Park Place to the middle of the East River) and $10,100,000 for the easterly section.

Typhoid Epidemic in Montreal

(*Continued from p. 876*)

been attributed to milk. Until the order of the provincial director of health on May 18, this was said to be the supply of a single dealer. About April 20, unofficial reports state the cause was more specifically laid to a typhoid carrier, working for this dealer, who had then been removed from contact with the supply. Some 95 per cent of all the milk delivered in Montreal was pasteurized, and up to April 11 there had been no typhoid among consumers of unpasteurized milk. Whether the dealer in question was one of the two now charged with responsibility for the epidemic does not appear.

Notable features of the measures taken to deal with the epidemic were the inoculation of 45,000 persons against typhoid, 8,000 first inoculations in one day, in which the Sun Life Assurance Company of Canada played a large part, and the nursing and educational work done by welfare departments of the Metropolitan Insurance Co., New York City.

California Water Right Law May Be Amended Next Year

One of the results of the recent agitation over California water law brought about by the Herminghaus case which was reviewed in *Engineering News-Record*, Feb. 3, p. 205, was the consideration by the last session of the California Legislature of several proposed laws intended to clarify and improve the present water code.

The outcome of the matter has been a decision to submit to the voters of California next year an amendment to the state constitution restricting the use of water to beneficial use. Included in the proposed measure is the following: "Because of the conditions prevailing in this state the general welfare requires that the water resources of the state be put to beneficial use to the fullest extent of which they are capable and that the waste or unreasonable use, or unreasonable method of use of water be prevented and that the conservation of such waters is to be exercised with a view to the reasonable and beneficial use thereof in the interests of the people and for the public welfare."

Maine Railway Work Abandoned

During the course of the controversy in the Maine Legislature over the construction of the Fish River Storage Reservoir by the International Paper Co. in Maine, it was stated that Senator Gould had definitely abandoned his plans for building the Quebec Extension Railroad. Preliminary work on the railroad was started in the latter part of December, 1926, in order to keep alive the Interstate Commerce Commission's certificate authorizing construction which would otherwise have expired at the end of the year. The railroad was to have been built across northern Maine into Quebec, a distance of 111 miles.

New Buildings for Purdue

Construction of a material testing laboratory and the first wing of a metallurgical engineering laboratory is to be begun at Purdue University this summer. The former, an addition to the present civil engineering building, will cost about $118,000 complete, of which the first section will represent about $120,000. For engineering equipment, the state legislature has appropriated $90,000, of which $50,000 will be available this year and the remainder in 1928.

More Railway Construction in Oregon Authorized

Following the failure of the Oregon Trunk Ry. and the Southern Pacific Ry. to agree over joint operation of certain railway lines in Oregon, the Interstate Commerce Commission has authorized the Oregon Trunk Ry. to proceed with the construction of additional trackage which would have been avoided if an operating agreement could have been made. The commission's order recommending that such an agreement be made authorizing the construction of about 360 miles of railroad in Oregon and northern California was reported in *Engineering News-Record*, June 24, 1926, p. 1014. Briefly, the commission then authorized the Oregon Trunk Ry. to construct a new line from Bend to Paunina on the Natron cutoff of the Southern Pacific, but declined to anthorize the construction which it now approves, namely, from Paunina south to Klamath Falls, in all about 160 miles. The Central Pacific Ry. (Southern Pacific System) was authorized to build from a point near Klamath Falls southeast to Cornell, Calif., and thence southeast to a connection with the Nevada-California-Oregon Ry. at Alturas, Calif., also to convert the latter narrow-gage railway into a standard-gage line. In addition, the Southern Pacific was authorized to control the Oregon, California & Eastern Railway Co., which in turn was authorized to build an extension from its northerly terminus at Sprague River, 63 miles to Silver Lake, with a 15-mile branch along the Williamson River and a branch from Sprague River southeasterly 65 miles to Lakeview. This construction was conditioned upon either the Southern Pacific or the Oregon, California & Eastern granting certain trackage rights to the Oregon Trunk Ry.

The present order of the commission requires that the Oregon Trunk Ry. accept its authorization on or before June 17, 1927.

RAILWAY CONSTRUCTION AUTHORIZED IN OREGON

Tri-Borough Bridge Project Is Postponed

No action was taken by the Board of Estimate and Apportionment of New York City on the Tri-Borough Bridge project to connect the borough of Queens with Manhattan and the Bronx by a bridge roughly paralleling the Hell Gate bridge of the New York Connecting R.R. with a westerly connection to 125th St., Manhattan. The city authorities stated that they favor building this structure by a special board patterned after the Port Authority and authorized to finance the project by the sale of bonds to be refunded by tolls. This plan cannot be carried out without favorable legislative action.

Engineers Agree on West Side Plan at New York

The committee of engineers appointed on July 1, 1926 by the mayor of New York to study and report upon the plan for the removal of the New York Central tracks on the west side of Manhattan Island, has reported to the mayor that it has reached an agreement on the subject and has submitted plans to him for his consideration. The report has been given out but detail plans have not been made public.

As far as it is possible to tell from the report, the plan calls for abandonment of the railroad company's tracks below Canal St. and the elevation of the tracks below the 30th St. yards with an elevated terminal north of Spring St. between West St. and Washington St. From the Spring St. terminal to West 13th St. the tracks will be located over an arcade along the western side of Washington St. inside the property line. From that point the elevated structure will be located on the easterly side of and parallel to 10th Ave. as far as 16th St. where it will cross 10th Ave. and enter a private right-of-way parallel to and about 100 ft. west of the building line, continuing in this right-of-way as far as the 30th St. yard. Within the yard the tracks will come down to a depressed roadway located between 10th and 11th Aves. extending from West 36th St. to the 60th St. yard where the tracks will again ascend to the present surface within the limits of the yard and continue generally in the position now occupied to the Harlem River where a new lift bridge is to be constructed. The location of the depressed railway north of 36th St. is not definitely stated.

The only surface tracks remaining will be those leading to the mail pier, float bridges and a new connection in 12th Ave. to the terminal warehouse.

The committee which made the report consists of William C. Lancaster, chairman, chief engineer of the Metropolitan Division of the Public Service Commission; J. R. Slattery, deputy chief engineer of the Board of Transportation; Arthur S. Tuttle, chief engineer of the Board of Estimate; C. M. Pinckney, chief engineer, office of the Borough President of Manhattan; Billings Wilson, deputy manager, Port of New York Authority; and R. E. Dougherty, engineering assistant to the president, New York Central R.R. Co.

Brief News

At the Fourth Annual Meeting of the Illinois Association of Sanitary District Trustees, to be held at Elgin, Ill., on June 8 and 9, one of the features will be the formal dedication of the new sewage disposal plant by E. N. Herbster, president of the association and also president of the Sanitary District of Elgin. G. H. Radebaugh, Urbana, Ill., is secretary of the association.

As a Result of Financial Arrangements just completed between the city of St. Catherines, Ontario, and the county of Lincoln, the short route to Buffalo, between St. Catherines and the Peace Bridge, obviating the difficulties consequent upon the tremendous congestion at the Niagara Falls bridges, will be an accomplished fact within a few months. Contracts for the work of paving the road between St. Catherines and Welland will be let shortly and it is expected the new highway will be open about the time the Peace Bridge is ready.

Putting the Pacific Great Eastern Ry. in British Columbia into first-class physical condition will start early in June, it is announced. Preparations are now nearing completion for the commencement of the program of improvements and replacements, to cost around $3,000,000 over a three-year period, and which will involve the expenditure of $750,000 this season. Equipment has been assembled at Squamish, B. C., and other points on the line in preparation for the season's operations, the most extensive undertaking since construction of the road was stopped.

Dams to Regulate the Flow of the Riviere a l'Ours at St. Felicien, Quebec, to provide a uniform supply of power for the mills in the district are to be constructed. Notice has been given by the Compagne Hydraulique de St. Felicien, and the plans and specifications showing the project have been sent to the provincial Department of Lands and Forests.

The Apprenticeship Commission of the New York Building Congress will hold its fourth annual commencement exercises at the Washington Irving High School, New York City, May 27, at 8 p.m. The program will include presentation of the Fenner Medal of the congress to one apprentice in each trade for which the apprenticeship commission provides instruction. Fenner Medals will be awarded annually. They are made possible by the creation of the Burt L. Fenner Memorial Fund of the New York Building Congress, in honor of the late Burt L. Fenner, first president of the apprenticeship commission.

The New Line of the Southern Pacific Co., from Tepic to La Quemada in Mexico, 103 miles, which provides a through line from the southwestern part of the United States to Mexico City, was opened to through traffic on April 15.

San Gabriel Dam Plans Adopted; To Open Bids July 11

Final plans for the large dam to be built on the San Gabriel River by the Los Angeles Flood Control District have been adopted, according to a telegram to *Engineering News-Record*, from E. C. Eaton, chief engineer of the district, and bids will be opened on July 11. The plans have been recently revised to conform to recommendations made by an engineering advisory board consisting of C. D. Marx, F. H. Fowler and Charles H. Paul, retained to report to the supervisors. A review of the findings of this board was published in *Engineering News-Record*, April 7, p. 570. Subsequent to the revision advised in this report and as the plans now stand, they have the approval of the supervisors and the Flood Control District's board of consulting engineers.

The dam is to have a total height above bedrock of 445 ft., will contain about 3,100,000 cu.yd. of concrete and the reservoir is to have a total capacity of 180,000 acre-ft. The estimated cost is $25,800,000.

Utilities Commission Planned for San Francisco

Discussion of the bond election to be held in San Francisco June 14 to pass upon the purchase of the Spring Valley Water Co. properties has developed a demand for a public utilities commission. Accordingly an amendment to the city charter has been accepted by the supervisors and ordered placed on the ballot of the general election to be held Nov. 6, 1928. Pending action on this amendment the supervisors are considering a plan for temporary operation of the Spring Valley Water properties if the bond issue for their purchase is approved at the election next month.

The commission proposed by charter amendment would have three members to hold office six years (one to go out of office every two years) and to be appointed by the mayor and confirmed by the board of supervisors. Each commissioner would be paid $20 for each meeting attended, but the maximum received would be $2,000 per annum.

The commission would have absolute control of "the construction, management, supervision, maintenance, operation, extension and control of all public utilities used, owned, leased, acquired and constructed by the city and county of San Francisco"; it would have authority to sell bonds voted for these purposes and would fix rates and fares; and would be required to appoint a utility manager who, with the submanagers of the several bureaus, would report directly to the commission and would be removable at its pleasure. Water and transportation would be the bureaus to be established first and a power bureau would be organized if and when the city actually enters the power business. So long as the various utilities were self-supporting the commission would have absolute control and would refer to the board of supervisors only if and when money from the general tax fund was needed.

Personal Notes

ROBERT CRAMER, consulting engineer, Milwaukee, Wis., and a member of the Milwaukee Sewerage Commission, has been appointed chief engineer of the commission. The office of chief engineer had been vacant since the resignation of T. Chalkley Hatton last December and the affairs of the commission were under the direction of an operating committee consisting of members of the engineering staff. Mr. Cramer is a native of Austria, but of American parentage. He is a graduate of Austrian engineering schools. For the past six years he has been in consulting practice in Milwaukee. From 1912 to 1917 he was chief engineer of the Winslow High Pressure Boiler Co., Chicago, and from 1917 to 1921 chief engineer of the Kingsford Foundry and Machine Works, Oswego, N. Y.

COL. WILLIAM J. BARDEN, Corps of Engineers, who has been division engineer of the North Pacific Division and district engineer at Seattle, Wash., will be transferred in June to New York City, to be division engineer of the Northeast Division and district engineer of the Third New York District.

HAROLD F. GRAY, Berkeley, Calif., announces that he is available for consultation and supervision of work as sanitary and hydraulic engineer.

T. G. MCCRORY has been appointed district engineer of the Washington Highway Department for a district including Whatcom, Skagit, Snohomish and King Counties, Washington, with headquarters in Seattle. For the past ten years he has been with the King County engineer's office in charge of bridges and maintenance of gravel and paved roads. He succeeds RICHARD WILSON of Seattle.

B. F. COLMER, Atlanta, Ga., who was released from the Georgia Railway and Power Co. over a year ago to take charge of the field supervision of the erection of a hydro-electric plant for the Bibb Mfg. Co. at Porterdale, Ga., has completed that work and has returned to his former position with the Georgia Power Co. as superintendent of building construction.

RALPH H. STEARNS has left the General Engineering and Management Corp. and has entered the offices of Mead and Scheidenhelm, consulting hydraulic engineers, New York City.

DANIEL R. MCFARLAND has been named as resident engineer on the San Gabriel dam which is to be built as part of the Los Angeles County flood control work. Mr. McFarland was resident engineer on the Exchequer dam.

CON WILLIAMS, of Rhinelander, has been appointed county engineer for Oneida County, Wisconsin, to succeed CHARLES GROSS, who has resigned.

T. CHALKLEY HATTON, whose resignation as chief engineer of the Milwaukee Sewerage Commission and of the Metropolitan Sewerage Commission of the County of Milwaukee, was recorded in these columns Jan. 20, p. 131, announces that he has established an office at 490 Broadway, Milwaukee, Wis., as consulting engineer in matters concerning the design and operation of sewage-treatment plants, and the formation and operation of metropolitan sewerage and water districts.

Engineering Societies

Calendar

Annual Meetings

SOCIETY OF INDUSTRIAL ENGINEERS, Chicago, Ill.; Annual Meeting, Chicago, Ill., May 24-27, 1927.

CONFERENCE OF STATE SANITARY ENGINEERS, Washington, D. C.; Annual Meeting, Chicago, Ill., June 4-6, 1927.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago, Ill.; Annual Convention, Tulsa, Okla., June 6-8, 1927.

AMERICAN INSTITUTE OF QUANTITY SURVEYORS, Chicago, Ill.; Annual Meeting, Washington, D. C., June 6-8, 1927.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Meeting, Chicago, Ill., June 6 to 11, 1927.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, French Lick, Ind., June 20-24, 1927.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, New York City; Annual Meeting, Orono, Maine, June 27-30, 1927.

The Fourth Annual Convention of the Canadian Good Roads Association will be held at Niagara Falls, Ontario, Sept. 27-29, 1927. A committee is already at work preparing the program of addresses and discussions which will occupy the time of the six business sessions. George A. McNamee, Montreal, Quebec, is secretary-treasurer.

The New York Section, American Society of Civil Engineers, at its annual meeting May 18 elected for the year 1927: John P. Hogan, president; George W. Kittredge, vice-president; and Daniel W. Mead, treasurer. T. R. Kendall and W. F. Reeves were elected directors. Harry D. Winsor is secretary of the section. The subject discussed at the meeting was "Progress in Aerial Surveying." Gerard H. Matthes was the principal speaker.

The Conference of State Sanitary Engineers, which will hold its annual meeting in Chicago June 4 to 6, announces its provisional program, to include final reports of committees on Sanitary Conservation of Streams, on Review, and on Swimming Pools and Bathing Beaches; and progress reports of committees on Pumps, Sewage Treatment, Camp and Outdoor Sanitation, Ventilation, Sanitation of Real Estate Developments, and on Shellfish. Papers and discussions will be given on "Sodium Aluminate in Water Purification," by S. T. Powell and C. A. Christman; "Standardization of Chlorine Tank Valve Connection," by A. E. Gorman; "Should All Well Water Be Chlorinated?" by H. F. Ferguson; a paper on oil in pumping equipment of the deep-well type; "Retardation of Chlorine Reaction in Water," by Earnest Boyce; and "Garbage Disposal," by H. B. Hommon.

Obituary

FRANK H. CRANDALL, a civil engineer of Burlington, Vt., died in that city May 7 after a short illness. He graduated from the University of Vermont in 1896 and soon after became assistant superintendent of the water-works of that city. From 1888 to 1905 he was superintendent of those works. In 1901 he was elected president of the New England Water-Works Association. Since 1905 he has been a member of the firm of McIntosh & Crandall, engaged in various lines of municipal and other civil engineering work.

NEEDHAM E. WADDELL, of the staff of The Foundation Co., New York City, died April 29, at the age of 42 years. He was the son of Dr. J. A. L. Waddell, was born in Tokio, Japan, in 1884, and was graduated in 1908 from Rensselaer Polytechnic Institute. Later, with the McClintic-Marshall Co., he helped build a Missouri River bridge at Kansas City. Then he served with the Grand Trunk Ry., in Canada. With Waddell and Harrington and later with Dr. Waddell, he handled general bridge work including construction, as contractor's engineer, of a highway bridge at Lexington, Mo. He entered the employ of The Foundation Co. in 1926 and at the time of his death was assistant to the general manager of the metropolitan district of that company.

EINAR A. JOHNSEN, chief mechanical engineer of the American Gas and Electric Co., died at a New York hospital May 13, from pneumonia, aged 49 years. Mr. Johnsen was born in Norway and graduated from Christiania Engineering College in 1902. Following three years in Norwegian copper mines, he became associated with Alfred Noble, consulting engineer for the Pennsylvania tunnels under the Hudson and East Rivers in New York. He then took part in constructing the foundations for the Hudson Terminal building. After the completion of the Hudson tubes, Mr. Johnsen went to Detroit as engineer for the contractors for the Michigan Central tunnels under the Detroit River, and then went to Haiti to superintend the construction of government wharves. In 1915 he joined the American Gas and Electric Co. and has represented this company in the design and construction of the Beech Bottom Power Station at Windsor, W. Va. Following the construction of the Windsor plant came those at Philo, Ohio, in 1920; Twin Branch, Ind., in 1922; and Stanton, Pa., in 1925. His last work was as representative of the American Gas and Electric Co. in designing the enlargement of the Philo station, which will include one of the largest electric generators in the world, with a capacity of 165,000 kw. His home was at Mountain Lakes, N. J.

T. HORACE BOWYER BROWNE, 64 years old and for almost 50 years a member of the chief engineer's department of the Baltimore & Ohio Railroad, Baltimore, died at his home in Baltimore on May 16. He had been ill for a number of weeks.

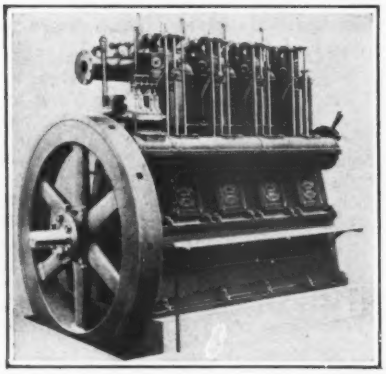
Water-Works Equipment and Materials

A Section Devoted to What the Manufacturer is Doing for the Water-Works Engineer and Operator

New Line of Diesel Engines for Water-Works Installation

A new line of Diesel engines is now being marketed by the Chicago Pneumatic Tool Co., New York City, in sizes ranging from 80 to 240 hp. at 327 r.p.m. These engines are of the Benz design, manufacturing rights for which were recently acquired by the Chicago Pneumatic Tool Co. from the German owners. The engines are of four-cycle, high compression, solid injection type, the two-cylinder, 80-hp. engine weighing 170 lb. per horsepower while the six-cylinder, 240-hp. engine weighs 100 lb. per horsepower. The engines are intended for small general power purposes and isolated or small power plant drives, and as standby units in larger power stations. It is claimed that the engines are foolproof to a very high degree.

Main bearings, crank pin bearings and piston pin bearings are lubricated by means of a pressure feed system, and the pistons by splash from the crank throws. All cams run in oil. Oil



is circulated by a gear type pump. The engine is started by means of compressed air from an air tank which charges from the engine itself during operation.

Copper Bearing Steel Pipe With Galvanized or Rubber Coating

A new pipe made of copper alloy steel has been perfected by the American Spiral Pipe Works, Chicago, which is claimed to combine strength of steel with a greater resistance to corrosion than has heretofore been accomplished. The adoption of copper bearing steel was based on numerous tests which had proved the advantage of an alloy of copper and steel in resisting rust and corrosive actions.

After completion of the manufacturing process the full pipe length with flanges is completely immersed in a bath of molten zinc. This is allowed to drain off slowly, leaving a smooth uniform coating over the surfaces. Pipe is made in sizes from 3 to 42 in. in diameter and in lengths up to 40 ft., as required, the standard length being 20 ft.

For piping requiring a non-metallic coating, one of mineral rubber is used. Pipe up to 40-ft. lengths is dipped in a hot bath of mineral rubber and then allowed to drain vertically insuring an even coating.

Comparator Set for Determining Residual Chlorine

The chlorine comparator is a recent development of the LaMotte Chemical Products Co., Baltimore, Md., to be used for the determination of residual

chlorine in water. The important feature of this piece of apparatus is that it eliminates the effects on the reading of color and turbidity of the sample.

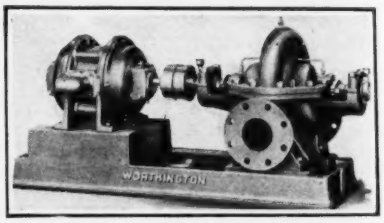
The set consists of five chlorine color standards with values of .1, .2, .4, .6 and 1.0 p.p.m. of chlorine in sealed glass ampoules, test tubes for holding the samples and other necessary apparatus in a wooden case approximately 8 in. long, 2½ in. wide and 5½ in. high as illustrated.

The operation of the comparator is based upon the fact that when water containing free chlorine is treated with orthotolidine reagent, a definite color is obtained. The top of the case first is removed and used as a comparator block, the six holes (three in each row) back of the slots holding the color standards and sample tubes. Three of the graduated test tubes are filled with the liquid to be tested and placed in the three holes directly back of the slots. To the middle hole is added 0.5cc. of orthotolidine reagent. A tube of distilled water is placed in the middle of the remaining three holes and two of the chlorine color standards in the holes on each side. Looking through the three pairs of tubes while holding them toward the light, and changing the color standards if necessary until the central pair of tubes exactly matches one of the other pairs, or else lies between the colors of the other pairs, constitutes the operation of the test. The amount of free chlorine can, of course, then be read from the standards.

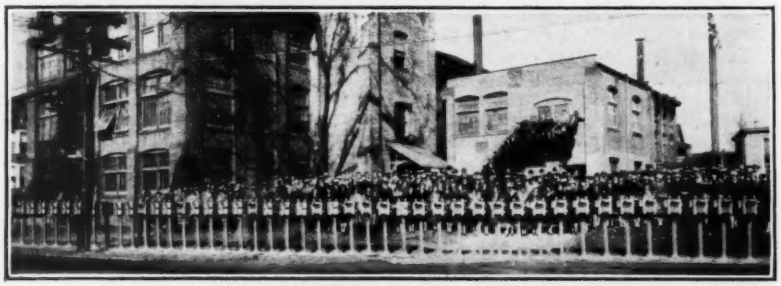
This piece of apparatus is an adaptation of the company's block comparator for making hydrogen ion determination. Indeed the company has developed a swimming pool set to test for both chlorine and pH, the former by means of the orthotolidine reagent and the latter by means of Phenol red color standards. The chlorine comparator was developed by the company with the co-operation of L. H. Enslow, research engineer of the Chlorine Institute.

High Efficiency Developed by New Centrifugal Pump

A new line of general service pumps recently developed by the Worthington Pump & Machinery Corp., New York City, is claimed to develop efficiencies from 8 to 10 points higher than average centrifugal pumps on similar serv-



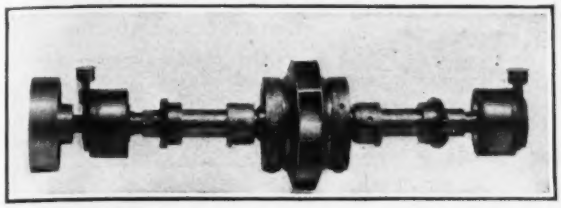
ice. The pumps are available in capacities from 50 to 2,000 g.p.m. for heads up to 150 ft. and for standard motor



Chlorinators for 22 Chilean Cities

Forty-four chlorinators were recently shipped by Wallace & Tiernan Co., Inc., Newark, N. J., to the Inspeccion del Agua Potable y Desagues of Chile, which is a governmental department having charge of the water supplies of the country. These chlorinators will be used in 22 different cities.

speeds up to 3,600 r.p.m. The new line embraces single-suction and double-suction types. It is stated that models for higher heads and greater capacities will soon be available. One point of interest in connection with the pumps is that their design is based upon users' requirements as determined by some 10,000 inquiries which were sent out.



The pump casing is horizontally split and so designed as to produce a smooth flow with no abrupt changes in velocity from the suction inlet to the discharge outlet. The suction passage is of volute form. In the single-suction pumps the back of the impeller acts as a hydraulic balance while the double-suction types are of course hydraulically balanced. All the pumps are equipped with deep-groove ball bearings, the outboard bearing being mounted to take any unbalanced thrust in either direction. Each bearing operates in a one-piece hardened steel housing held in place by a yoke. By removing the housing yokes, the complete shaft with bearings and bearing housings can be removed and replaced without disturbing pump alignment. One of the accompanying illustrations shows a pump of double-suction type while the other shows the complete rotor removed.

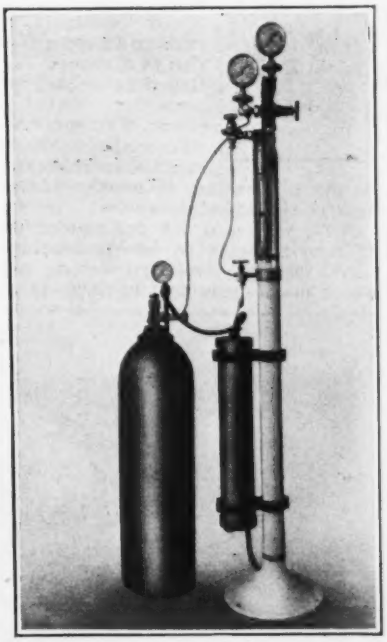
Gooseneck for Underground Service Connections

S-bend goosenecks of annealed standard size brass pipe represent one of the recent developments in the products made by the American Brass Co., Waterbury, Conn., for waterworks installation. The red brass pipe manufactured by the company is especially corrosive-resistant and besides is strong and ductile, so that it may be bent to avoid ordinary trench obstructions. The radius of bend in a gooseneck should be about 4 in. for ¾-in. standard pipe and should be proportionately increased for larger sizes of pipe. It is claimed that the flexibility of such gooseneck connections exceeds that of a swing-joint connection. The pipe either may be bent by the user or if ordered in sufficient quantities will be furnished to specifications by the company.

New Chlorinator Has Fewer Parts

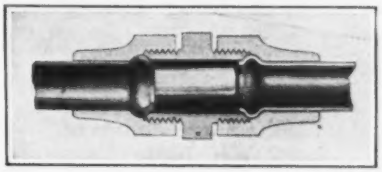
A new type of solution feed chlorinator has just been intrduced by the Paradon Manufacturing Co., Arlington, N. J., known as its DBS series and in which it is claimed there are fifty less parts than in the older type. This, it is said, has been made possible by eliminating the usual injector and substituting for it a hard rubber solution jar. Whereas on the old type the injector operated a vacuum relief to prevent the flooding of the machine, the new series obtains protection from flooding by a vacuum relief consisting of an oil-sealed check valve on the chlorine line. The same standard control unit is used as in the old injector type.

The operation of the machine is as follows: The chlorine measured by the control unit is conveyed by its own pressure through a silver tube to the hard rubber mixing chamber, through which a constant small auxiliary water-supply flows. The chlorine is bubbled into this water supply through a silver diffuser. The top of the hard rubber chamber is equipped with a manually operated silver lined shut-off valve and an oil vacuum relief. In case the shut-off valve is not closed through oversight or because the chlorine supply is exhausted, the vacuum relief will automatically break any vacuum that might tend to form in the system. As a further safeguard, the usual meter pressure valve is so constructed that it will hold chlorine pressure for two or three days should the chlorine supply become exhausted or the machine be shut down without closing the shut-off valve. The hard rubber jar is also equipped with a drain, thus giving in all four independent protections against flooding of the apparatus.



Threadless Connection for Copper Service Pipe

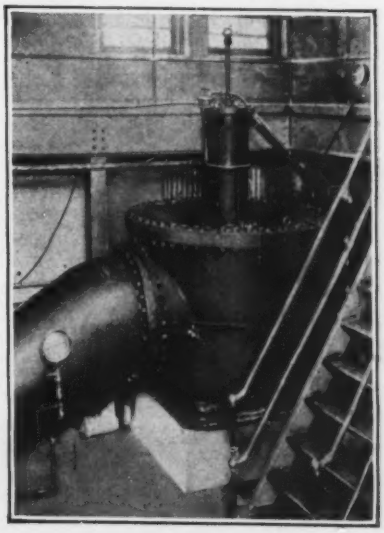
A new type of threadless connection for copper service pipe has been developed by the Glauber Brass Mfg. Co., Cleveland, Ohio, which as shown in the illustration is made by forming a bead on the body of the pipe a short distance from the end. Grooved seats are machined on the end of the spud to conform to the bead on the copper pipe and a corresponding grooved seat is also machined on the bottom of the coupling nuts. It is claimed that this arrangement results in a durable and perfectly watertight joint and at the same time restricts in no way the area of the water passage cross-section. A beading tool is furnished with which it is claimed the joint can be made in a minimum of time. The beading tool will make joints in all sizes of copper service pipes from ¾ to 2½ in. inclusive.



Automatic Cone Valves Designed for Efficient Check-Valve Service

A special valve has recently been designed and tested in the 68th St. pumping station in Chicago, for which a number of advantages are claimed. The factors which the design hoped to eliminate were loss of head from excessive friction caused by restrictions in the pipe lines by "flappers" and the leakage practically always found in using ordinary check valves. The valve is similar to a corporation cock. It provides a clear pipeway and, therefore, the least amount of friction. In order to make the plugs rotate freely an axial movement is introduced to lift the plug from contact with the casing before it is rotated.

The automatic operation of the valve is dependent on the rise and fall of pressure on the pump side of the valve, the pressure operating a hydraulic cylinder connected to the cone plug. It is also possible to operate the valve manually. The valve can be completely closed while the pump is running and throttled to any position desired, to regulate the amount of flow without interfering with the automatic closing of the valve. In a recent test a 36-in. valve connected to a 30-m.g.d. electric centrifugal pump

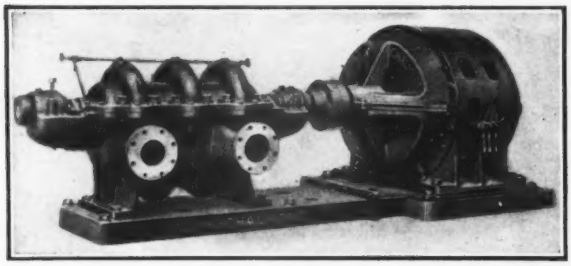


operating against 50-lb. pressure closed in 5 seconds from the time the power was cut off from the pump.

These tests are said to have proved the claims that the valve prevents reversal of the pump, eliminates rams, surges and water hammer. The valve is manufactured by the Automatic Cone Valve Co., 32 West Randolph St., Chicago, Ill., and was designed by David D. Goldberg.

Multi-Stage Pumps of New Design

There has been developed during the past year by the Allis-Chalmers Mfg. Co., Milwaukee, Wis., a new line of multi-stage pumps which are made up of several double-suction impellers



mounted in a single casing, each discharging into a volute passage, the nozzle of which leads around to the suction of the succeeding impeller. This design makes a multi-stage pump, having the advantages of single-stage design as regards efficiency, freedom from end-thrust difficulties and desirable operating characteristics. It makes available for city pumping service multi-stage pumps which are claimed to be simpler and more efficient than the types which have heretofore been supplied when the heads were higher than could be pumped against in a single stage. In the accompanying illustration is shown a 6x5-in., three-stage, double-suction, multi-stage pump of this new design.

Diaphragm Pump Units Operated Through Transmission Gears

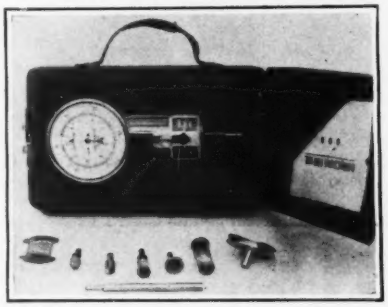
A gasoline-engine-driven diaphragm pumping unit, rated at 4 hp., delivering 185 g.p.m. at 15-ft. lifts, is the recent product of the Domestic Engine & Pump Co., Shippensburg, Pa., for which are claimed a number of advantages. It has an easily opened in-

take valve which increases the suction lift and discharge capacity. A large hand hole port insures perfect drainage of the pump and permits easy removal of large stones or trash which may be drawn into the pump bowl. The unit is known as the DL-4. The one-cylinder engine delivers power to the pump walking beam through a special dirt-proof, self-oiling plunger type of speed-reducing transmission. Roller bearings are used throughout.

Hand Tachometers for Checking Engine and Motor Speeds

The hand tachometer manufactured by O. Zernickow Co., 15 Park Row, New York City, indicates accurately: (1) R.p.m. right or left of shafts, spindles, etc. (2) Feet per minute right or left of flywheels, pulleys, belts, drums, etc. (3) Speed variations occurring during a fraction of a second. (4) Belt slipping and consequently waste of power. To operate, the pointer of the tachometer, shown in its case in the illustration, is merely pressed against the object under test.

All spindles in the tachometer are of steel mounted on bronze bearings. Gears are of steel and bronze and watch precision is used in finishing all



parts. The housing of the tachometer is made of aluminum alloy. Each tachometer has several ranges, each available by moving a gear shift with the thumb. It would often prove profitable if engineers and contractors checked the output of their machines more frequently and tachometers offer one of the best and simplest methods.

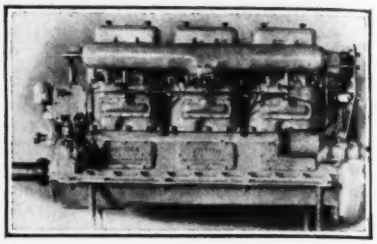
Roofing and Siding of Steel Encased in Lead

Two surfaces of pure lead sealing a core of copper steel is the description of "Lead-Sealed" a new sheet metal roofing and siding, according to its manufacturers, The Superior Sheet Steel Co., Canton, Ohio. Its use, will at first be confined largely to industrial structures where the advantages of light weight, moderate cost and fire protection coupled with resistance to smoke, acid fumes, salt air and moisture provided by the lead surfaces are important.

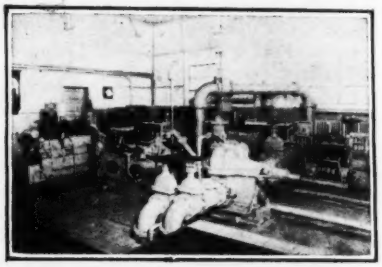
The manufacturer states that the process employed in making Lead-Sealed is exclusive and assures perfect sealing of the base metal in the protective lead. It is being made in corrugated roofing and siding, and flat sheets, Nos. 12 to 28 gage.

New Gasoline Engine for Waterworks Pumping

A new six-cylinder engine has recently been developed by the Buffalo Gasoline Motor Co., Buffalo, N. Y., for waterworks pumping service. This is known as Type R and is designed



and built for speeds up to 1,500 r.p.m. The bore is 5½ in. and the stroke 7 in.; normal horsepower is 125 to 175.



The engine is of a valve-in-head type with removable cylinder heads; it has seven camshaft bearings and seven crankshaft bearings. Full pressure lubrication is used throughout. One of the accompanying illustrations shows a unit direct connected to a centrifugal pump in a water station.

Manufacturers and Trade Associations

Calendar

Annual Meetings

WATERWORKS MANUFACTURERS ASSOCIATION, New York; Annual meeting, Chicago, June 6-10.

NATIONAL HARDWOOD LUMBER ASSOCIATION, Chicago; Annual Convention, Chicago, Sept. 15-16.

AMERICAN PAINT & VARNISH MANUFACTURERS ASSOCIATION, Philadelphia; Annual Convention, Atlantic City, Oct. 24-25.

NATIONAL ASSOCIATION OF MANUFACTURERS; Annual meeting, Chattanooga, Tenn., October 25, 26 and 27.

ASPHALT ASSOCIATION, New York; Annual Convention, Atlanta, Nov. 28-Dec. 2.

Business Side of Construction

Facts and Events That Affect Cost and Volume

This Week's Contracts—With Comparisons

Minimum costs observed are: $15,000 for water-works and excavation, drainage, irrigation, levee, river and harbor projects; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, institutional, religious and other buildings.

Week ended	Public Work	Private Work	Total Contracts
May 26, 1927	$18,931,000	$45,733,000	$64,664,000
May 19, 1927	32,923,000	51,247,000	84,170,000
May 27, 1926	18,122,000	40,018,000	58,140,000
Jan. 1 to date			
1927	435,110,000	728,201,000	1,163,311,000
1926	400,515,000	721,867,000	1,122,382,000

E.N.-R. Index Numbers On May 1, 1927

COST	VOLUME
206.80	*257*

The Index Numbers are published in detail and with charts in the first issue of each month. The Cost Index is given in full from 1903 through 1926, with a thorough explanation of its method of computation, and a graphic comparison with many other index numbers, in the 18-page pamphlet entitled Engineering News-Record Construction Costs.

Water-Works Construction on New Plane of Expenditure Since 1923

Placing Per Capita Expenditures on 1913 Purchasing Basis Shows Increase Is Sound Return to Normal Volume

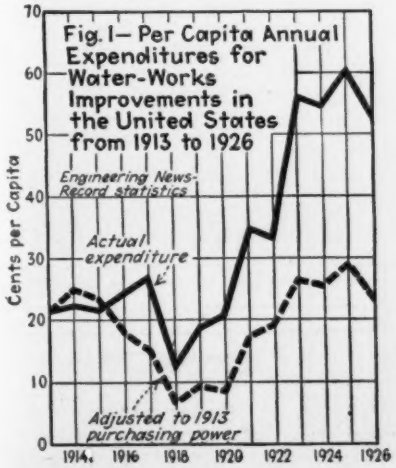
WATER-WORKS construction, like most other construction in the United States, has climbed up to a new standard of cost. A glance at the heavy curve in Fig. 1 proves this. From 1913 to 1920, water-works improvements per capita per year ranged from 12.2 cents to 27.3 cents. The average for the period was a trifle over 20 cents. All figures used in this article are *Engineering News-Record* Statistics covering contracts of $15,000 and more.

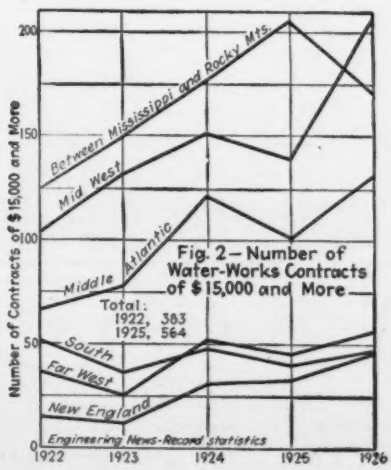
A distinct upturn occurred in 1921, when the per capita expenditure was 35.5 cents compared with 20.8 cents the year before. The rise continued until 1923, which seems to mark the arrival at the new standard. The figures have been:

56.6 cents in 1923
54.9 cents in 1924
61.0 cents in 1925
53.6 cents in 1926

Large as this increase is in terms of money, it does not represent overbuilding. When these figures are adjusted to a common base, by dividing the figure for each year by the *Engineering News-Record* Construction Cost Index Number for that year, they show instead of inflation a healthy return to the normal rate of construction. The broken line in Fig. 1 shows the movement of these adjusted figures. It is seen that the recovery in contract-letting, beginning in 1921, was at approximately the same rate as the slow-down from 1915 to 1918. The two sets of annual per capita figures—actual and adjusted to 1913—are as follows:

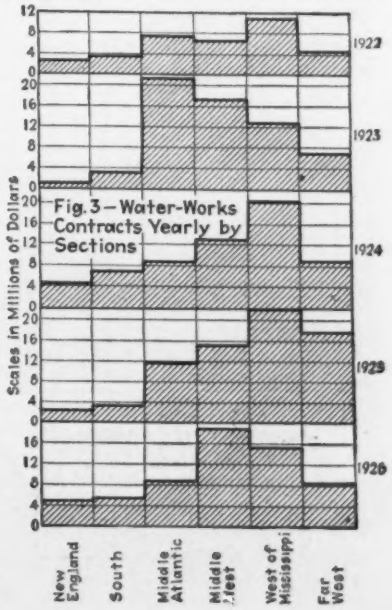
	Actual Cents	Adjusted to 1923 Cents
1913	21.5	21.5
1914	22.5	25.4
1915	21.7	23.5
1916	24.1	17.8
1917	27.3	15.2
1918	12.2	6.5
1919	18.8	9.5
1920	20.8	8.3
1921	35.5	17.5
1922	33.4	19.2
1923	56.6	26.4
1924	54.9	25.5
1925	61.0	29.5
1926	53.6	23.5





Another view of the picture is given by Fig. 2, which shows the actual number of water-works contracts of $15,000 and more, as reported in Construction News in the last five years. The annual number of these jobs is increasing. The total was 383 in 1922; in 1925 it was 564, and 690 in 1926. The greatest activity is in the Middle Atlantic states, in the Mid-West and in the vast region between the Mississippi River and the Rocky Mountains.

Regional activity is still further analyzed in Fig. 3. Here is shown for each year since 1922 the value in millions of dollars of the water-works contracts let in each section of the country. Reading from left to right for each year gives the relative value of water-works construction in each section. Reading vertically gives the variation from year to year in each section. While there are occasional large variations such as the increase in the Middle Atlantic states in 1923, these can usually be explained by the awards of a few large improvements rather than by a general speeding up.



May Prices of Eight of The Principal Materials For Last Fifteen Years

Quotations Shown at Important Centers, 1913 to 1927—Steady at Present—Protracted Decline Probable

PRICES of the basic construction materials, particularly those shown in the accompanying illustrations, display certain tendencies in common, when figures for the last fifteen years are compared.

Quotations on cast-iron pipe, cement, concrete aggregates, reinforcing material, brick and lime are taken as of May each year, from 1913 to date.

Not only May prices but those for the other months, appear to have shown receding tendencies during the period marked by the outset of the World War, followed by the sharp upward movement culminating in the 1920 peak. After that, came the post-war deflation which, in turn, was checked by the general construction boom started in 1922 and continuing throughout the five years ending with 1926.

The present trend is downward but gradually so. The decline in prices of materials has evidently gained sufficient momentum to overcome the rising tendencies of labor rates, resulting in a steady downward pressure on construction cost in general.

Quotations covered in the graphs are for large shipments, that is, cargo or carload quantities or over.

The accompanying tables show prices, as of the first week in each month, on the three principal materials in this group, 1913 to 1927.

CEMENT, PER BBL., WITHOUT CHARGE FOR BAGS, CARLOAD LOTS, TO CONTRACTORS, F.O.B. CHICAGO

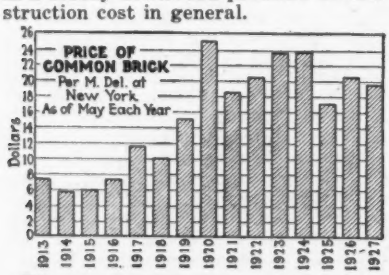
	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1913.....	$1.19	$1.19	$1.19	$1.19	$1.19	$1.19	$1.19	$1.19	$1.19	$1.19	$1.19	$1.19
1914.....	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.16	1.16	1.16	1.16	1.16
1915.....	1.02	1.06	1.11	1.11	1.11	1.11	1.16	1.16	1.16	1.21	1.26	1.31
1916.....	1.31	1.31	1.31	1.41	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.56
1917.....	1.56	1.56	1.66	1.76	1.76	1.91	1.91	1.91	1.81	1.81	1.81	1.81
1918.....	1.81	1.81	1.81	1.96	1.96	1.96	2.05	2.05	2.05	2.05	2.05	2.05
1919.....	2.05	2.05	2.05	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
1920.....	2.00	2.00	2.00	2.00	2.15	2.15	2.15	2.25	2.35	2.37	2.37	2.37
1921.....	2.37	2.37	2.17	2.17	2.17	2.17	2.17	2.17	2.17	1.97	1.97	1.97
1922.....	1.97	1.97	1.94	1.97	1.97	1.97	2.05	2.05	2.20	2.20	2.20	2.20
1923.....	2.05	2.05	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.10
1924.....	2.10	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20
1925.....	2.10	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.10	2.10
1926.....	2.10	2.10	2.10	2.10	2.10	2.20	2.10	2.10	2.10	2.10	2.10	2.10
1927.....	2.10	2.05	2.05	2.05	2.05	.....	.....	.....	.....	.....	.....	.....

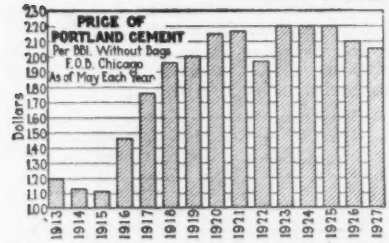
COMMON BRICK, PER M, DELIVERED, NEW YORK

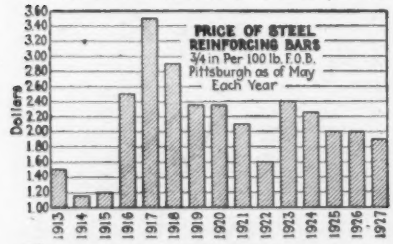
1913.....	$6.88	$6.88	$7.18	$7.13	$7.13	$7.25	$7.00	$6.88	$6.25	$6.00	$6.00	$6.50
1914.....	5.75	6.25	6.25	5.75	5.65	5.75	5.75	.....	.....	5.25	5.13	5.25
1915.....	5.00	5.94	5.25	5.75	5.88	6.25	6.25	5.50	5.88	6.75	6.75	.....
1916.....	8.50	8.50	8.50	8.50	7.25	8.25	8.00	8.00	7.25	7.00	7.75	9.50
1917.....	9.00	9.50	9.50	9.50	11.50	10.25	9.25	8.50	8.50	8.25	8.25	8.25
1918.....	8.75	10.00	10.25	10.25	10.00	10.25	11.50	14.00	14.00	14.00	14.00	14.00
1919.....	14.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	16.00	24.70	.....
1920.....	22.50	25.00	25.00	25.00	25.00	25.00	25.00	25.00	30.75	22.70	22.70	22.70
1921.....	22.70	22.70	22.70	21.70	18.40	18.40	18.40	18.40	18.40	18.90	18.40	18.40
1922.....	17.90	20.40	21.40	19.65	20.40	23.05	24.60	23.50	22.40	19.10	17.73	18.28
1923.....	23.50	23.50	23.50	23.50	23.50	23.50	23.50	25.15	23.65	23.65	23.00	22.55
1924.....	23.65	24.75	24.75	23.65	23.65	23.65	23.65	20.15	17.00	17.00	18.00	18.00
1925.....	18.00	18.00	18.00	17.00	17.00	18.50	19.50	18.50	17.75	17.75	18.00	18.50
1926.....	18.50	20.40	21.00	20.40	20.50	20.40	20.40	21.40	21.40	21.40	21.40	21.40
1927.....	21.40	21.40	21.40	19.50	19.50	.....	.....	.....	.....	.....	.....	.....

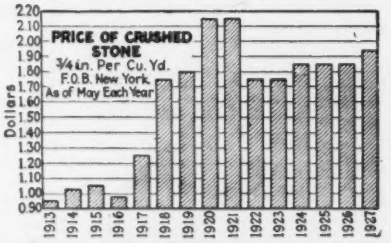
CAST-IRON PIPE, PER TON, 6-IN., F.O.B. BIRMINGHAM

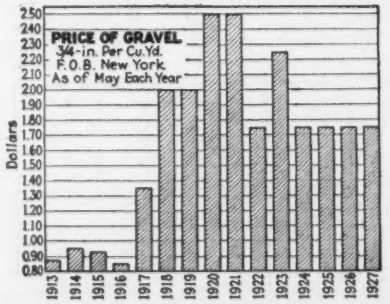
1913.....	$23.00	$23.00	$22.00	$22.50	$21.50	$20.50	$20.50	$20.00	$20.00	$20.00	$20.00	$19.00
1914.....	19.00	19.00	19.00	18.50	18.50	18.50	18.50	18.50	18.50	18.50	18.50	18.00
1915.....	17.85	17.85	17.85	17.85	17.85	17.85	18.35	18.35	19.35	19.85	21.85	21.85
1916.....	23.35	24.60	24.60	25.60	25.60	25.60	25.85	25.85	25.85	26.35	26.35	34.35
1917.....	36.35	36.35	37.35	45.35	50.35	53.35	60.35	60.35	60.35	60.35	45.35	50.35
1918.....	49.15	49.15	49.15	49.15	49.15	54.90	55.25	55.25	55.00	60.00	60.00	60.00
1919.....	60.00	55.00	55.00	50.00	50.00	45.00	45.00	47.00	49.00	49.00	53.00	56.00
1920.....	60.00	63.00	66.00	66.00	70.00	70.00	70.00	70.00	70.00	74.00	74.00	74.00
1921.....	55.00	55.00	55.00	55.00	55.00	45.00	40.00	40.00	35.00	34.00	33.00	32.00
1922.....	35.00	35.75	33.00	32.75	34.50	34.50	37.50	37.00	37.50	40.50	43.00	43.25
1923.....	43.00	43.00	45.00	48.00	49.00	49.00	49.00	49.00	49.00	49.00	49.00	49.00
1924.....	49.00	49.00	49.00	48.00	48.50	49.00	49.00	50.00	50.00	50.00	44.50	40.00
1925.....	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	41.00	41.50	41.50	41.50
1926.....	41.50	41.50	41.50	41.50	41.50	41.50	41.50	40.00	40.00	40.00	40.00	39.00
1927.....	38.00	37.00	38.00	38.00	38.00	.....	.....	.....	.....	.....	.....	.....

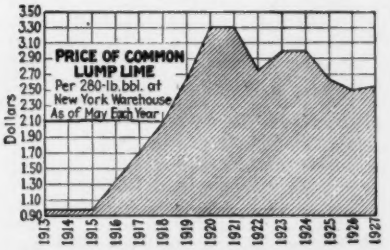


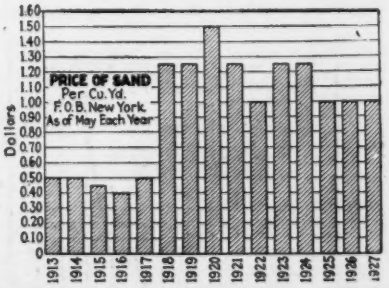


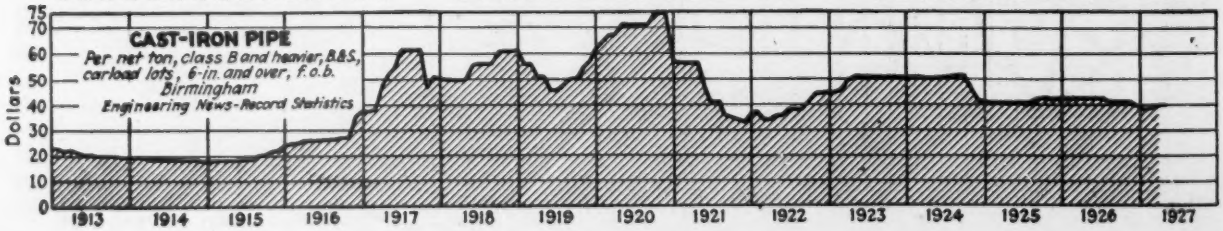











CAST-IRON PIPE
Per net ton, class B and heavier, B&S, carload lots, 6-in. and over, f.o.b. Birmingham
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